RFP No. 612-005, Part B

Request for Proposal

Bioscience Education Center
Phase 2 – Building, Gateway Signage and Road Construction

Germantown Campus

VOLUME 2
Building Construction Specifications

Montgomery College
Maryland

Date: March 26, 2012
Montgomery College
Office of Central Facilities
40 W. Gude Drive – Suite 200
Rockville, MD 20850

Bioscience Education Center
Phase 2 – Building, Gateway Signage and Road Construction
Germantown Campus

TABLE OF CONTENTS

VOLUME I

INTRODUCTORY INFORMATION

PROPOSAL REQUIREMENTS

CONTRACT REQUIREMENTS

VOLUME 2 – BUILDING CONSTRUCTION

TECHNICAL SPECIFICATION SECTIONS

DIV. 08 DOORS AND WINDOWS

DIV. 09 FINISHES

DIV. 10 SPECIALTIES

VOLUME 3 – BUILDING CONSTRUCTION

DIV. 20 RESERVED

200000 Common Mechanical / Electrical Requirements

DIV. 21 FIRE SUPPRESSION

210500 Common Work Results for Fire Suppression
211000 Fire Suppression Commissioning
211200 Fire Suppression Standpipes
211313 Wet-Pipe Sprinkler Systems

DIV. 22 PLUMBING

220500 Common Work Results For Plumbing
220516 Expansion Fittings And Loops For Plumbing Piping
220519 Meters And Gages For Plumbing Piping
220523 General-Duty Valves For Plumbing Piping
220529 Hangers And Supports For Plumbing Piping And Equipment
220553 Identification For Plumbing Piping And Equipment
220700 Plumbing Insulation
220800 Plumbing System Commissioning
221113 Facility Water Distribution Piping
221116 Domestic Water Piping
221119 Domestic Water Piping Specialties
221120 Domestic Water Packaged Booster Pumps
221123 Facility Natural-Gas Piping
221316 Storm Drainage And Sanitary Waste And Vent Piping
221123 Facility Natural-Gas Piping
221316 Storm Drainage and Sanitary Waste and Vent Piping
221319 Sanitary Waste And Storm Piping Specialties
221429 Sump Pump
221513 Laboratory Service Piping
221600 Laboratory Neutralization System
222620 Package Laboratory Vacuum Pump And Receiver
223300 Electric Domestic Water Heaters
223400 Fuel-Fired Domestic Water Heaters
224000 Plumbing Fixtures
224700 Drinking Fountains And Water Coolers
226119 Compressed Air Equipment
226700 Reagent Grade Water System
226710 Purified Water Piping

DIV. 23 HEATING VENTILATION AND AIR CONDITIONING

DIVISION 26 – ELECTRICAL

DIV. 27 COMMUNICATIONS

VOLUME 4 - GATEWAY SIGNAGE

DIVISION 31 – EARTHWORK

DIV. 32 EXTERIOR IMPROVEMENTS

DIV. 33 (NOT USED)

VOLUME 5 – OBSERVATION DRIVE EAST-WEST ROAD AND TRAFFIC CIRCLE

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 02 – EXISTING CONDITIONS

DIVISION 03 – CAST-IN-PLACE CONCRETE

DIVISION 22 - PLUMBING

DIVISION 33 – EARTHWORK

DIVISION 32 – EXTERIOR IMPROVEMENTS

DIVISION 33 – UTILITIES

END OF TABLE OF CONTENTS, PART B

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work by Owner.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Future work.
8. Work restrictions.
9. Specification and drawing conventions.
10. Miscellaneous provisions.

B. Related Requirements:

1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

A. Project Identification: Bioscience Education Center (BE) Phase 2 – Building.

1. Project Location: 20200 Observation Drive, Germantown, MD 20876.

B. Owner: Montgomery Community College.

1. Owner's Representative: Cynthia Johnson, Director of Project Management
Montgomery College
Office of Central Facilities
40 West Gude Drive
Rockville, MD 20850

C. Architect: The Lukmire Partnership, Inc.
2700 South Quincy Street, Suite 300
Arlington, VA 22206

D. Architect's Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. ARCHITECT OF RECORD:
   The Lukmire Partnership
   2700 South Quincy Street, Suite 300
   Arlington, VA 22206
   703 998 0101

2. ASSOCIATE ARCHITECT:
   Mitchell/Giurgola Architect, LLP
   170 West 97th Street
   New York, New York 10025
   212 663 4000

3. MEP ENGINEER:
   R.G. Vanderweil Engineers, LLP
   625 North Washington Street
   Alexandria, VA 22314
   703 683 9700

4. STRUCTURAL ENGINEER:
   ReStl Designers, Inc.
   702 Russell Ave, Suite 400
   Gaithersburg, MD 20877
   301 258 0933

5. CIVIL ENGINEER:
   A. Morton Thomas & Associates, Inc.
   12750 Twinbrook Parkway
   Rockville, MD 20852
   301 881 2545

6. LAB PLANNER:
   SST Planners, Inc.
   1501 Wilson Blvd, Suite 507
   Arlingon, VA 22209
   703 875 8787

7. LANDSCAPE ARCHITECT:
   Mahan Rykiel Associates, Inc.
   800 Wyman Park Drive, Suite 100
   Baltimore, MD 21211
   410 235 6001

8. AUDIOVISUAL/IT CONSULTANT:
   Convergent Technologies Design Group, Inc.
   6501 York Road
   Baltimore, MD 21212
   410 532 2395

9. SECURITY CONSULTANT:
   The Protection Engineering Group, Inc.
   14900 Bogle Drive, Suite 200
   Chantilly, VA 20151
   703 488 9990

10. SITE UTILITIES CONSULTANT:
Richter & Associates
15865 Crabbs Branch Wat
Rockville, MD 20855
301 548 7475

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. Phase 2 is the third stage in a multi-phased construction project for a new science building, the Bioscience Education Center, on the Germantown Campus of Montgomery College. The project involves construction of an approximately 141,000 square feet three story lab and academic building, including a mechanical penthouse, and consists of steel frame and composite slab construction. Functions include instructional laboratories, classrooms, administrative and support spaces, a science learning center, and a conference center. The exterior skin is a combination of brick on block masonry, composite aluminum panel, and glazed aluminum curtain wall. The building is designed to comply with the requirements of Construction Type 2B per the International Building Code (IBC) 2009, and is a mixed use, separated uses with Use Group A3 Assembly and Use Group B Business. The project has a mandated minimum silver LEED rating, but is expected to attain a gold rating. Work includes final grading and paving immediately adjacent to the building, utility connections, and landscaping.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.5 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

B. Preceding Work: Phase 1 of the project included site clearing, rough grading and minor demolition, including a portion of the building footprint and grading for the new greenhouse complex. Work included related erosion control measures and established the construction entrance for the project. Phase 1 work is now substantially complete.

C. Concurrent Work:

1. Phase 1B involves site work to construct a new parking lot, a new four lane public road with a new campus entrance, continuation of an inner campus two lane road which will connect existing campus roadways to form a complete campus loop road, mass grading for the complete project site including the building pad and relocation of a 24" water main, other utility work (gas line relocation and installation, sewer, electrical work, relocation of county and private communication lines), paving, storm water management, sediment control and landscape work.

2. Erection of a greenhouse, hoop house, and associated shed building at the northeast corner of the site, along with utility connections back to the HT building. These shall remain operational and accessible throughout the Phase 2 construction.

3. Construction of a four lane public road, Observation Drive East-West, utility installation and traffic circle.

1.6 ACCESS TO SITE

A. General: Contractor shall have full use of Building Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project. Building project site is identified on Project Key Plan.

B. Access to Site: All construction access to the project Site shall be from Middlebrook Road along the new segment of Observation Drive, currently under construction. Deliveries and construction traffic shall not be allowed to use the campus entrance from Germantown Road (Rt. 118).

C. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.7 COORDINATION WITH OCCUPANTS

A. Full Owner Occupancy: Owner will occupy site and adjacent building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, and other adjacent occupied or used facilities. Do not close or obstruct walkways, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

B. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.

2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

B. Related Requirements:

1. Division 01 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

A. Unit price is an amount incorporated in the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement for unit prices are specified in those Sections. Take measurements and compute quantities.

C. Contractor shall engage a qualified Geotechnical Engineer and be responsible for all geotechnical costs.

D. College and Geotechnical Engineering Agency will verify measurements and quantities.

E. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

1. Provide unit prices to establish a fixed basis for costs for adding or changing specified quantities of work from those indicated in the contract drawings and specifications, when directed in writing by the College to make such changes. The unit prices shall include all labor, materials, equipment, overhead, bonds, insurance and profit.

2. Where the unit price schedule designates an estimated quantity for the work, Contractor shall indicate in the appropriate place on the Bid Form a total price for the work and a unit price, with the total price equal to the unit price times the estimated quantity stated.
3. This total price shall be included in the Total Bid Price for the Work.
4. The Contract sum will be adjusted by Change Order by applying the bid unit price to the actual quantity of work in excess of, or less than, the quantity stated in the Bid.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

A. **Unit Price No. 1** – Removal of contaminated soil.

1. If contaminated soil is encountered during excavation, remove and properly dispose of the contaminated soil.

END OF SECTION 012200

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 CHANGES IN THE WORK

1. Changes in the work will be documented by bulletin issued by the Architect, with corresponding action instruction provided by the Owner

a. Sample cover page is included at the end of this section.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

Montgomery College

BULLETIN XXX

Contract Number: XXX

Date: Month DD, YYYY

Subject/Project Number:	**Cc: (Electronic)**
Montgomery College – Germantown Campus Bioscience Education Center Phase 2 MHEC Number: CC-01-MC-397	☒ cynthia.johnston@montgomerycollege.edu ☒ gretchen.rimkus@montgomerycollege.edu ☒ catherine.baugh@montgomerycollege.edu ☒ kalisa.bell@montgomerycollege.edu ☒ jimb@rosscontracting.com ☒ nikkid@rosscontracting.com ☒ dhallett@lukmire.com ☒ mwychulis@amtengineering.com

☐ **Construction Change Directive**

The modifications to the contract documents described herein are issued as a construction change directive. The contractor shall proceed with the changes immediately and submit proposed adjustment to the contract sum and contract time in accordance with the contract as stipulated by the Montgomery College General Conditions 000700 Article 6.1.

☐ **Change Order Request**

The modifications to the contract documents described herein are not for construction. The contractor shall submit a detailed written proposal and shall not proceed with the work without a written change order signed by the owner and contractor as stipulated by the Montgomery College General Conditions 000700 Article 6.1.

☐ **Minor Change in the Work**

The modifications to the contract documents described herein are minor changes in the work. The contractor shall proceed with the changes immediately as stipulated by the Montgomery College General Conditions 000700 Article 6.1.4.

☐ **Time and Materials**

The modifications to the contract documents described herein are issued as a change to be handled on a time and material basis. The contractor shall proceed with the changes immediately and shall track time and material costs in accordance with the contract as stipulated by the Montgomery College General Conditions 000700 Article 6.1.3.4.

THIS CHANGE IS NOT VALID UNLESS SIGNED BELOW

Montgomery College
Authorization to proceed: _____
Signature Print Name Date

Description:

Description

Contract Documents

Drawings:

Sheet No.	Sheet Title

Project Manual:

Section No.	Shection Title

Supplementary Drawings:

Sheet No.	Sheet Title

End of Bulletin XXX

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. Requests for Information (RFIs).
4. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
4. Section 019113 "General Commissioning Requirements" for coordinating the Work with College's Commissioning Authority.

1.3 DEFINITIONS

A. RFI: Request from College, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Submit in accordance with the Instructions for Bidders a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for College and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as College's property.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

    a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
    b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
    c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
    e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
    f. Indicate required installation sequences.
    g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

    a. Runs of vertical and horizontal conduit 1-inch in diameter and larger.
    b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
    d. Location of pull boxes and junction boxes, dimensioned from column center lines.

8. Fire-Protection System: Show the following:

    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."

1.7 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in accordance with the Montgomery College General Conditions Section 4.2.

1. Architect will return RFIs submitted by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: Software-generated form acceptable to Architect with substantially the same content as AIA Document G716.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow a reasonable amount of time, but at least five working days for Architect's response for each RFI. RFIs received by Architect after 3:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for approval of Contractor's means and methods.
d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.
f. Requests for interpretation of Architect's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify the College's Project Manager and the Architect in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log at Progress Meetings. Include the following:

1. Project name.
2. Name and address of Contractor.
3. RFI number including RFIs that were returned without action or withdrawn.
4. RFI description.
5. Date the RFI was submitted.
6. Date Architect's response was received.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within five days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT MEETINGS

A. General: Schedule meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify College and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including College and Architect, within three days of the meeting.

B. Preconstruction Conference: Architect and College will schedule and conduct a preconstruction conference before starting construction.

1. Conference will review responsibilities and personnel assignments.
2. Attendees: Authorized representatives of College, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Tentative construction schedule.
    b. Critical work sequencing and long-lead items.
    c. Designation of key personnel and their duties.
    d. Lines of communications.
    e. Procedures for processing field decisions and Change Orders.
    f. Procedures for RFIs.
    g. Procedures for testing and inspecting.
    h. Procedures for processing Applications for Payment.
    i. Distribution of the Contract Documents.
    j. Submittal procedures.
    k. LEED requirements.
    l. Preparation of record documents.
    m. Use of the premises.
    n. Work restrictions.
    o. Working hours.
    p. Responsibility for temporary facilities and controls.
    q. Procedures for moisture and mold control.
    r. Procedures for disruptions and shutdowns.
    s. Construction waste management and recycling.
    t. Parking availability.
    u. Office, work, and storage areas.
    v. Equipment deliveries and priorities.
    w. First aid.
    x. Security.
    y. Progress cleaning.

4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. LEED Coordination Conference: College will schedule and conduct a LEED coordination conference before starting construction, at a time convenient to College, Architect, and Contractor.

1. Attendees: Authorized representatives of College, College's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent and LEED coordinator;

major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Discuss items of significance that could affect meeting requirements for LEED certification, including the following:

    a. LEED Project Checklist.
    b. General requirements for LEED-related procurement and documentation.
    c. Project closeout requirements and LEED certification procedures.
    d. Role of LEED coordinator.
    e. Construction waste management.
    f. Construction operations and LEED requirements and restrictions.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

D. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, and College's Commissioning Authority of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.
    e. Purchases.
    f. Deliveries.
    g. Submittals.
    h. LEED requirements.
    i. Review of mockups.
    j. Possible conflicts.
    k. Compatibility requirements.
    l. Time schedules.
    m. Weather limitations.
    n. Manufacturer's written instructions.
    o. Warranty requirements.
    p. Compatibility of materials.
    q. Acceptability of substrates.
    r. Temporary facilities and controls.
    s. Space and access limitations.
    t. Regulations of authorities having jurisdiction.
    u. Testing and inspecting requirements.
    v. Installation procedures.
    w. Coordination with other work.
    x. Required performance results.
    y. Protection of adjacent work.
    z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

E. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to College and Architect, but no later than 30 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of College, College's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

    a. Preparation of record documents.
    b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
    c. Submittal of written warranties.
    d. Requirements for completing LEED documentation.
    e. Requirements for preparing operations and maintenance data.
    f. Requirements for delivery of material samples, attic stock, and spare parts.
    g. Requirements for demonstration and training.
    h. Preparation of Contractor's punch list.
    i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
    j. Submittal procedures.
    k. College's partial occupancy requirements.
    l. Installation of College's furniture, fixtures, and equipment.
    m. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

F. Progress Meetings: Plan and participate in progress meetings no less than biweekly intervals, or as determined.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of College, College's Commissioning Authority and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties

involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Status of LEED documentation.
5) Deliveries.
6) Off-site fabrication.
7) Access.
8) Site utilization.
9) Temporary facilities and controls.
10) Progress cleaning.
11) Quality and work standards.
12) Status of correction of deficient items.
13) Field observations.
14) Status of RFIs.
15) Status of proposal requests.
16) Pending changes.
17) Status of Change Orders.
18) Pending claims and disputes.
19) Documentation of information for payment requests.

4. Minutes: College's project manager will record and distribute the meeting minutes to each party present and to parties requiring information.
5. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's construction schedule.
2. Construction schedule updating reports.
3. Daily construction reports.
4. Material location reports.
5. Site condition reports.
6. Special reports.

B. Related Requirements:

1. Division 01 Section "Submittal Procedures" for submitting schedules and reports.

1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF electronic file.
3. Two paper copies.

B. Startup construction schedule.

1. Approval of startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource

loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.

F. Construction Schedule Updating Reports: Submit monthly with Applications for Payment.

1. Construction Schedule Updating Reports shall be furnished monthly whether or not Contractor submits an application for payment in that month.

G. Daily Construction Reports: Submit at weekly intervals.

H. Site Condition Reports: Submit at time of discovery of differing conditions.

I. Special Reports: Submit at time of unusual event.

J. Qualification Data: For scheduling consultant.

K. Progress Documents: The Contractor shall keep one complete set of all Drawings, Specifications, construction progress schedule, and shop drawings at the job-site and in good order. As the Work progresses, the Contractor shall keep a complete and accurate record of all changes or deviations from the Contract Documents, indicating the Work as actually installed. All underground utility locations associated with the scope of work, or revealed during the conduct of the work, shall be recorded by the Contractor's surveyor and referenced to a campus benchmark provided by the College. All such changes shall be neatly and correctly shown on black line prints of the drawings affected, or in the Specifications, with appropriate supplementary notes. This record set of prints of Drawings, shop drawings and Specifications shall be kept at the job site for inspection by the College's Project Manager and Architect/Engineer.

1.4 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.

1.5 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
3. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

C. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and Contract Time.

D. Recovery Schedule: Whenever the project shall be behind schedule or alleged by either party to be behind schedule, the College may require the Contractor to furnish, at no additional cost to the College, revised schedule information (hereinafter called a "recovery schedule") showing how the Contractor will finish their work by the Contract completion date. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Preliminary Schedule:

1. The Contractor shall agree to comply with the Preliminary Project Schedule prepared by the College and included in the Contract Documents or with the Contractor's Proposed Project Schedule, if one was required as part of the Contractor's proposal submission. Agreement by the Contractor to comply with the Preliminary Project Schedule or Contractor's Proposed Project Schedule also means agreement by the Contractor to comply with subsequent reasonable updates prepared or requested by the College.
2. Within 14 days of the execution of the Contract, Contractor must submit for approval, preliminary schedule information outlining all activities for the Contractor's work as may be reasonably requested by the College's Project Manager. Coordinate schedule information with milestones indicated in the Preliminary Project Schedule. This preliminary information must be approved prior to the first Application for Payment

being processed. Include each significant construction activity, coordinate each activity with other activities and schedule each construction activity in proper sequence. The College's Project Manager may decline to issue a Notice to Proceed until Contractor has submitted the required schedule information and it is approved by the College's Project Manager. Nothing in this section shall be construed to require the College's Project Manager to issue a Notice to Proceed when the required schedule information has been submitted and approved.

3. With submission of the preliminary schedule information, include a listing by date of submission of all submittals required. Identify those required to maintain orderly progress of the Work, and those required early because of long lead time for manufacture or fabrication.

C. CPM Schedule: Prepare Contractor's construction schedule using a time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date of Contract execution.

    a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.

2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
3. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

    a. Preparation and processing of submittals.
    b. Mobilization and demobilization.
    c. Delivery.
    d. Utility interruptions.
    e. Installation.
    f. Punch list and final completion.
    g. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

    a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

2.3 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. Approximate count of personnel at Project site.
3. Equipment at Project site.
4. Material deliveries.
5. High and low temperatures and general weather conditions, including presence of rain or snow.
6. Accidents.
7. Meetings and significant decisions.
8. Unusual events (see special reports).
9. Stoppages, delays, shortages, and losses.
10. Meter readings and similar recordings.
11. Emergency procedures.
12. Orders and requests of authorities having jurisdiction.
13. Change Orders received and implemented.
14. Services connected and disconnected.
15. Equipment or system tests and startups.
16. Substantial Completions authorized.

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for

Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to ArchitectOwner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:
1. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
2. Division 01 Section "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's and College's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's and College's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and College and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect's and College's final release or approval.
    g. Scheduled date of fabrication.
    h. Scheduled dates for purchasing.
    i. Scheduled dates for installation.
    j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect and College reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. The College's Project Manager and Architect/Engineer will examine the shop drawings and product data submittals with reasonable promptness. The College's Project Manager and Architect/Engineer will note whether they are approved, approved with corrections and/or conditions, or rejected. The Architect/Engineer will return the shop drawings and project data submittals with the final action to the Contractor and also provide one copy each to the College and College's Project Manager.

C. Processing Time: The Contractor must allow the Architect/Engineer, College's Project Manager at least fourteen calendar days following receipt of each submittal or re-submittal of shop drawings and product data submittals to review the documents and respond to the Contractor. Items requiring longer than fourteen calendar days of review time will be identified in the

Specifications. The minimum time allowed for the Architect/Engineer, College's Project Manager to review the submittal shall be increased to the extent that additional time for review is needed due to the fault or the responsibility of the Contractor or its Subcontractors and suppliers. The Contractor will be notified of the cause of the delay and advised of how long it will take to complete the review; provided, however, that mere failure to give the Contractor such notice shall not entitle the Contractor to compensation or a time extension.

D. Electronic Submittals: At Contractor's option and if mutually acceptable by the Architect/Engineer and College, electronic submittals will be accepted for submittal documentation up to 11"x17" format. Samples, color charts, and shop drawings exceeding 11"x17" format must be submitted in hard copy. Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number followed by a decimal point and then an iteration number (e.g., MCBE-061000.01.01). Submittal of additional information from the same specification section will be designated by incrementing the sequential number (e.g., MCBE-061000.02.01). Resubmittals shall be identified by incrementing the iteration number (e.g., MCBE-061000.01.02).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner**,** containing the following information:

    a. Project name.
    b. Date.
    c. Name and address of Architect.
    d. Name of Contractor.
    e. Name of firm or entity that prepared submittal.
    f. Names of subcontractor, manufacturer, and supplier.
    g. Category and type of submittal.
    h. Submittal purpose and description.
    i. Specification Section number and title.
    j. Specification paragraph number or drawing designation and generic name for each of multiple items.
    k. Drawing number and detail references, as appropriate.
    l. Location(s) where product is to be installed, as appropriate.
    m. Related physical samples submitted directly.
    n. Indication of full or partial submittal.
    o. Transmittal number, numbered consecutively.
    p. Submittal and transmittal distribution record.
    q. Other necessary identification.
    r. Remarks.

E. Options: Identify options requiring selection by Architect and College.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents,

including minor variations and limitations. Include same identification information as related submittal.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

B. With each submittal indicated below, provide one copy to College coincident with submission to the Architect/Engineer.

1. Hard Copy Action Submittals: Submit a minimum of five paper copies of each submittal. Architect will retain one copy for the Architect, one for the Consultant, and two for the College, and will return remaining copies to the contractor.
2. Submit electronic submittals as PDF electronic files by email or post to FTP site specifically established for Project.

    a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

3. Informational Submittals: Submit a minimum of three paper copies of each submittal unless otherwise indicated. Architect and College will not return copies.
4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

    a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
    b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

C. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

    a. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.

D. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

    a. Identification of products.
    b. Schedules.
    c. Compliance with specified standards.
    d. Notation of coordination requirements.
    e. Notation of dimensions established by field measurement.
    f. Relationship and attachment to adjoining construction clearly indicated.
    g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

E. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.
    b. Product name and name of manufacturer.
    c. Sample source.
    d. Number and title of applicable Specification Section.
    e. Specification paragraph number and generic name of each item.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

4. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.

F. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.

G. Coordination Drawing Submittals: Comply with requirements specified in Division 01 Section "Project Management and Coordination."

H. Contractor's Construction Schedule: Comply with requirements specified in “General Conditions” and Division 01 Section "Construction Progress Documentation."

I. Application for Payment and Schedule of Values: Comply with requirements specified in “General Conditions” and Division 01 Section "Payment Procedures."

J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section "Closeout Procedures."

K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

L. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

M. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

N. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

O. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

P. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

Q. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

R. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product.

S. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

T. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect and College.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit a minimum of three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect and College.

B. Project Closeout and Maintenance Material Submittals: See requirements in Division 01 Section "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

A. Action Submittals: Architect and College will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:

1. Approved.
2. Approved as Noted.
3. Revise and Resubmit.
4. Rejected.

B. Informational Submittals: Architect and College will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect and College will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect and College.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
2. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 ACTION SUBMITTALS

A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.

1. Indicate manufacturer and model number of individual components.
2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 15 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager shall not have other Project responsibilities.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

    a. Provide test specimens representative of proposed products and construction.
    b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
    d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
    e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
    f. When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.

    a. Allow seven days for initial review and each re-review of each mockup.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed unless otherwise indicated.

K. Integrated Exterior Mockups: Construct integrated exterior mockup as indicated on Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

L. Room Mockups: Construct room mockups incorporating required materials and assemblies, finished according to requirements. Provide required lighting and additional lighting where required to enable Architect to evaluate quality of the Work. Provide room mockups of the following rooms:

1. Laboratory mock up as described in section 123400 "Laboratory casework – General requirements.

1.10 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction, as indicated in Statement of Special Inspections attached to this Section.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's,reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

Department of Permitting Services
255 Rockville Pike, 2nd Floor
Rockville, MD 20850-4166
Phone: 311 in Montgomery County or (240) 777-0311
Fax (240)-777-6262
http://www.montgomerycountymd.gov/permittingservices

DPS

Inspection-Statement of Special Inspection

Project Name: Montgomery College Germantown Bioscience Education Center

Project Address: 20200 Observation Drive, Germantown, MD 20876

Permit Number: (A/P):

Permit Applicant: Mr., David J, Capp, Vice President of Facilities and Security Phone: (240) 567-7362

Applicant's Address: 40 West Gude Drive, Suite 200, Rockville, MD 20850

Owner: Montgomery College Phone: (240) 567-5371

Owner's Address: 40 West Gude Drive, Suite 200, Rockville, MD 20850

Architectural Inspector (AI): N/A

Address:

License: Phone: ( )

Structural Engineer of Record (SER): Kishorchandra S. Mehta, ReStl Designers, Inc.

Address: 702 Russell Ave., Suite 400, Gaithersburg, MD 20877

License: 9841 Phone: (301) 258-0933

Mechanical Engineer of Record (MER): Donald Posson, R.G. Vanderweil Engineers, LLP

Address: 625 North Washington Street, Suite 300, Alexandria, VA 22314

License: 19514 Phone: (703) 683-2080

Geotechnical Inspector (GI): TBD

Address:

License: Phone: ( )

Special Inspector (SI): TBD

Address:

License: Phone: ( )

Testing Agency Engineer (if different from SI): TBD

Address:

License: Phone: ( )

Precast Concrete Engineer of Record (PER): N/A

Address:

License: Phone: ( )

General Contractor (GC): TBD

Address:

License: Phone: ( )

SCHEDULE OF SPECIAL INSPECTIONS

STRUCTURAL STEEL Reference: IBC Table 1704.3	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
1. Material verification of high-strength bolts, nuts and washers:		
a. Identification markings to conform to ASTM standards specified in the approved construction documents.	Periodic	
b. Manufacturer's certificate of compliance required.	Periodic	
2. Inspection of high-strength bolting:		
a. Snug-tight joints.	Periodic	
b. Pretensioned and slip-critical joints using the turn-of- nut with matchmarking, twist-off bolt or direct tension indicator methods of installation.	Periodic	
c. Pretensioned and slip-critical joints using turn-of-nut without matchmarking or calibrated wrench methods of installation.	N/A	
3. Material verification of structural steel and cold-formed steel deck:		
a. For structural steel, identification markings to conform AISC 360.	N/A	
b. For other steel, identification markings to conform to ASTM standards specified in the approved construction documents.	N/A	
c. Manufacturer's certified test reports.	Periodic	
4. Material verification of weld filler materials:		
a. Identification markings to conform to AWS specification in the approved construction documents.	Periodic	
b. Manufacturer's certificate of compliance required.	Periodic	

(Continued)

STRUCTURAL STEEL (Cont.) Reference: IBC Table 1704.3	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
5. Inspection of welding: a. Structural steel and cold-formed steel deck 1) Complete and partial joint penetration groove welds. 2) Multipass fillet welds. 3) Single-pass fillet welds > 5/16” 4) Plug and slot welds. 5) Single-pass fillet welds < or equal 5/16” 6) Floor and roof deck welds. b. Reinforcing steel: 1) Verification of weldability of reinforcing steel other than ASTM A 706. 2) reinforcing steel resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special structural walls of concrete and shear reinforcement. 3) Shear reinforcement. 4) Other reinforcing steel.	 Continuous Continuous Continuous Periodic Periodic Periodic Periodic N/A Periodic Continuous	
6. Inspection of steel frame joint details for compliance: a. Details such as bracing and stiffening. b. Member locations. c. Application of joint details at each connection.	 Periodic Periodic Periodic	
INSPECTION OF FABRICATORS AND FABRICATION PROCEDURES Reference: IBC Section 1704.2		

CONCRETE Reference: IBC Table 1704.4	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
1. Inspection of reinforcing steel, including prestressing tendons, and placement.	Continuous	
2. Inspection of reinforcing steel welding in accordance with IBC Table 1704.3, item 5b.	Continuous	
3. Inspection of bolts to be installed in concrete prior to and during placement of concrete where allowable loads have been increased or where strength design is used.	Periodic	
4. Inspection of anchors installed in hardened concrete.	Periodic	
5. Verifying use of required design mix.	Continuous	
6. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	Continuous	
7. Inspection of concrete and shotcrete placement for proper application techniques.	Periodic	
8. Inspection for maintenance of specified curing temperature and techniques.	Periodic	
9. Inspection of prestressed concrete: a. Application of prestressing forces. b. Grouting of bonded prestressing tendons in the seismic-force-resisting system	N/A	
10. Erection of precast concrete members.	Continuous. (County amendment).	
11. Verification of in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs. The strength evaluation shall be demonstrated by field cured cylinders only.	Continuous. (County amendment).	
12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	Periodic	

MASONRY (LEVEL 1) Reference: IBC Table 1704.5.1	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
1. Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified.	Periodic	
2. Verification of f'm and f'aac prior to construction except where specifically exempted by the IBC code.	Periodic	
3. Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	Continuous	
4. As masonry construction begins, the following shall be verified to ensure compliance:		
a. Proportions of site-prepared mortar.	Periodic	
b. Construction of mortar joints.	Periodic	
c. Location of reinforcement, connectors, prestressing tendons and anchorages.	Periodic	
d. Prestressing technique.	N/A	
e. Grade and size of prestressing tendons and anchorages.	N/A	
5. During construction the inspection program shall verify:		
a. Size and location of structural elements.	Periodic	
b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.	Periodic	
c. Specified size, grade and type of reinforcement, anchor bolts, prestressing tendons and anchorages.	Periodic	
d. Welding of reinforcing bars.	Continuous	
e. Preparation, construction and protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperature above 90 degrees F).	Periodic	
f. Application and measurement of prestressing force.	N/A	

MASONRY (LEVEL 1) (Cont.) Reference: IBC Table 1704.5.1	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
6. Prior to grouting, the following shall be verified to ensure compliance:		
a. Grout space is clean.	Periodic	
b. Placement of reinforcement and connectors, and prestressing tendons and anchorages.	Periodic	
c. Proportions of site-prepared grout and prestressing grout for bonded tendons.	Periodic	
d. Construction of mortar joints.	Periodic	
7. Grout placement shall be verified to ensure compliance:		
a. Grouting of prestressing bonded tendons.	N/A	
8. Preparation of any required grout specimens, mortar specimen and/or prisms shall be observed.	Periodic	

MASONRY (LEVEL 2) Reference: IBC Table 1704.5.3	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
1. Compliance with required inspection provisions of the construction documents and the approved submittals.	N/A	
2. Verification of f'm and f'aa prior to construction and for every 5,000 square feet during construction.	N/A	
3. Verification of proportions of materials in premixed or preblended mortar and grout as delivered to the site.	N/A	
4. Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	N/A	
5. The following shall be verified to ensure compliance: a. Proportions of site-prepared mortar, grout and prestressing grout for bonded tendons. b. Placement of masonry units and construction of mortar joints. c. Placement of reinforcement, connectors and prestressing tendons and anchorages. d. Grout space prior to grout. e. Placement of grout. f. Placement of prestressing grout. g. Size and location of structural elements. h. Type, size and location of anchorage of anchors, including other details of anchorage of masonry to structural members, frames or other construction. i. Specified size, grade and type of reinforcement, anchor bolts, prestressing tendons and anchorages. j. Welding of reinforcing bars. k. Preparation, construction and protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperature above 90 degrees F). l. Application and measurement of prestressing force.	N/A	
6. Preparation of any required grout specimens and/or prisms shall be observed.	N/A	

SOILS Reference: IBC Table 1704.7	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	Periodic	
2. Verify excavations are extended to proper depth and have reached proper material.	Periodic	
3. Perform classification and testing of compacted fill materials.	Periodic	
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill.	Continuous	
5. Prior to placement of compacted fill, observe subgrade and verify that site has been prepared properly.	Periodic	
DRIVEN DEEP FOUNDATION ELEMENTS Reference: IBC Table 1704.8	N/A	
1. Verify element materials, sizes and lengths comply with the requirements.		
2. Determine capacities of test elements and conduct additional load tests, as required.		
3. Observe driving operations and maintain complete and accurate records for each element.		
4. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element.		
5. For steel elements, perform additional inspections in accordance with IBC Section 1704.3		
6. For concrete elements and concrete-filled elements, perform additional inspections in accordance with IBC Section 1704.4		
7. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.		

CAST-IN-PLACE DEEP FOUNDATIONS Reference: IBC Table 1704.9	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
1. Observe drilling operations and maintain complete and accurate records for each element.	N/A	
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes.	N/A	
3. For concrete elements, perform additional inspections in accordance with IBC Section 1704.4	N/A	
SPRAYED FIRE-RESISTANT MATERIALS Reference: IBC Section 1704.12		
1. Tests and observations required		
a. Condition of substrates	Yes	
b. Thickness of application	Yes	
c. Density in pounds per cubic feet	Yes	
d. Bond strength adhesion/cohesion	Yes	
e. Condition of finished application	Yes	
MASTIC AND INTUMESCENT FIRE-RESISTANT COATINGS Reference: IBC Section 1704.13	Yes	
EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS). (Method of construction shall be reviewed and approved by the County). Reference: IBC Section 1704.14	N/A	
SPECIAL CASES Reference: IBC Section 1704.15	N/A	
SMOKE CONTROL SYSTEMS Reference: IBC Section 1704.16	N/A	

MECHANICAL INSPECTIONS		
See Section 1.7.5 of the Special Inspection Program Manual	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
1. Pressure testing of ductwork and various piping systems 2. Piping and duct supports and insulation 3. Fuel tank pressure testing and verification of proper UL listing 4. Inspection for seismic resistance in Seismic Design Category C 5. Proper protection of penetrations of fire rated building components 6. Appropriate protection of fire rated shaft penetrations 7. Emergency Standby Generators shall be installed and inspected per the IBC and NFPA 110 8. Hazardous exhaust systems shall be installed and inspected per the IMC and NFPA 45 9. General conformance to the County approved construction documents 10. Compliance with the International Energy Conservation Code regarding mechanical systems efficiencies, insulation, economizers and controls		

SHEETING AND SHORING	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
See Section 1.7.2 A of the Special Inspections Program Manual.		
UNDERPINNING	N/A	
See Section 1.7.2 B of the Special Inspections Program Manual.		

ARCHITECTURAL INSPECTIONS	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
See Section 1.7.6 of the Special Inspections Program Manual.	N/A - Building not over three stories	
WALL PANELS AND VENEERS	N/A	

COLD-FORMED STEEL LIGHT-FRAME	**EXTENT OF SERVICE** (Continuous or periodic)	**AGENT**
	Periodic	
WOOD	N/A	

PRECAST	**EXTENT OF SERVICES** (Continuous).	**AGENT**
See additional requirements in Chapter 3 of the Special Inspections Program Manual.	N/A	
OTHER INSPECTIONS (Explain)	N/A	

This statement of special inspection is submitted as a condition for permit. It includes a Schedule of Special Inspections applicable to this project. The SI shall keep records of specified inspections and testing. The SI shall furnish specified inspection and test reports to the County building official, and to the registered design professionals of record, as appropriate. All discrepancies shall be brought to the attention of the contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the code official and to the registered design professionals of record, as appropriate. Interim reports shall be submitted as required by the special inspection program manual. A Final Report of Special Inspections documenting completion of all required special inspections and correction of documented discrepancies shall be submitted prior to the issuance of an occupancy permit. By signing the SSI, you also affirm that you understand and will comply with the County requirements for Special inspections as outlined in the "SSI", "Special Inspection Program Manual", and the "Building Code".

Owner:

Type or print name **Date**

Signature

Inspecting Architect:

Type or print name **Date**

Signature

Structural Engineer of Record (SER):

Type or print name **Date**

Signature

Mechanical Engineer of Record (MER):

Type or print name **Date**

Signature

Geotechnical Inspector

Type or print name **Date**

Signature

Precast Concrete Engineer of Record (PER)

Type or print name **Date**

Signature

Special Inspector:

Type or print name **Date**

Signature

Testing Agency Engineer of Record (if different from SI):

Type or print name **Date**

Signature

General Contractor (GC):

Type or print name **Date**

Signature

County Code Official's Acceptance:

Type or print name **Date**

Signature

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Division 01 Section "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, testing agencies, and authorities having jurisdiction.

B. Utility Service from Existing Systems: The Contractor shall include in the Contract Sum all temporary connections and extensions of services as required for construction operations, separately meter and pay for utilities (electricity, water, sewer, and telephone) consumed, and remove the temporary installation and connections when no longer required; .

1.4 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide concrete or galvanized-steel bases for supporting posts.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
3. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Division 01 Section "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, College and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to College. At Substantial Completion, restore these facilities to condition existing before initial use.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Toilets: Use of Owner's existing toilet facilities will not be permitted.

3.3 SUPPORT FACILITIES INSTALLATION

A. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as required.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touchup signs so they are legible at all times.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Division 01 Section "Summary."

C. Temporary Erosion and Sedimentation Control: Comply with requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Division 31 Section "Site Clearing."

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

F. Site Enclosure Fence: Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.

1. Extent of Fence: As indicated on Drawings.
2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION 015000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and Patching
5. Coordination of Owner-installed products.
6. Correction of the Work.

B. Related Requirements:

1. Division 01 Section "Summary" for limits on use of Project site.
2. Division 01 Section "Submittal Procedures" for submitting surveys.
3. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor.

B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.

C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:

1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
2. Changes to In-Place Construction: Describe anticipated results.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.4 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect and College for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect and College according to requirements in Division 01 Section "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect and College promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architect and College when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect and College.

3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect and College. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect and College before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

G. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Division 01 Section "Summary."

D. Existing Utility Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to prevent interruption to occupied areas.

E. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or

adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
2. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.
3. Proceed with patching after construction operations requiring cutting are complete.

F. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.

G. Cleaning: Clean areas where cutting and patching are performed.

3.7 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction personnel.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

1. Construction Schedule: Inform College of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify College if changes to schedule are required due to differences in actual construction progress.
2. Preinstallation Conferences: Include College''s construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

    a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section "Construction Waste Management and Disposal."

F. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period.

G. Limiting Exposures: Supervise construction operations to assure that no part of the construction ,completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Disposing of nonhazardous and construction waste.

B. Related Requirements:

1. Division 31 Section "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

1.4 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

1.6 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
2. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Division 01 Section "Temporary Facilities and Controls."

B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Division 0Division 01 Section "Execution" for progress cleaning of Project site.
2. Division 01 Section "Project Record Documents" for submitting record Drawings, record
3. Divisions 31 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 ACTION SUBMITTALS

A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Divisions 31 Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.
2. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
3. Complete final cleaning requirements.
4. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: When the Work is substantially completed, the Contractor shall notify the College's Project Manager and Architect/Engineer in writing that the Work will be ready for final inspection and testing on a definite date. Reasonable notice shall be given by the Contractor to permit the College's Project Manager and Architect/Engineer to schedule the final inspection. On receipt of request, Architect and College will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

E. List of Incomplete Items (Punch List): Following Inspection, Architect will issue the List of Incomplete Items (Punch List).

F. If it is determined that Substantial Completion has been achieved, the College's Project Manager shall fix the time within which the Contractor shall complete any remaining items of Work which will be indicated on the punch list. If the Contractor fails to complete the remaining items so listed in the time stipulated, the College shall have the undisputed right to complete the Work at the Contractor's expense. The Contractor may be required to complete multiple punch lists until the Contract is performed in its entirety. Failure to complete punch list work in a timely manner shall constitute grounds for termination of the Contract for default. Final payment shall not be made until all Contract work, including all punch list work is complete to the satisfaction of the College's Project Manager.

1.7 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to General Conditions.
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

1.8 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

1. Clean Project site in areas disturbed by construction activities of rubbish, waste material, litter, and other foreign substances.
2. Remove tools, construction equipment, machinery, and surplus material from Project site.
3. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste disposal requirements in Division 01 Section "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Product maintenance manuals.

B. Related Requirements:

1. Section 011200 "Multiple Contract Summary" for coordinating operation and maintenance manuals covering the Work of multiple contracts.
2. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
3. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect and Commissioning Authority will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
b. Enable inserted reviewer Comments on draft submittals.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Architect will return two copies.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.

1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Name and address of Project.
2. Name and address of Owner.
3. Date of submittal.
4. Name and contact information for Contractor.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference

Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

C. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared record Drawings in Section 017839 "Project Record Documents."

D. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:

1. Division 01 Section "Execution" for final property survey.
2. Division 01 Section "Closeout Procedures" for general closeout procedures.
3. Division 31 Sections for specific requirements for project record documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit minimum of three (3) sets of marked-up record prints.

B. Record Specifications: Submit minimum of three (3) copies of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit minimum of three (3) copies of each submittal.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit three (3) paper copies of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    b. Accurately record information in an acceptable drawing technique.
    c. Record data as soon as possible after obtaining it.
    d. Record and check the markup before enclosing concealed installations.
    e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

    a. Dimensional changes to Drawings.
    b. Revisions to details shown on Drawings.
    c. Locations and depths of underground utilities.
    d. Changes made in accordance with Section 012600 “Contract Modification Procedures”.
    e. Details not on the original Contract Drawings.
    f. Field records for variable and concealed conditions.
    g. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, Bulletin numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Architect.
    e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.

B. Format: Submit record Specifications as paper copy.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.

B. Format: Submit record Product Data as paper copy.

1. Include record Product Data directory organized by Specification Section number and title.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as paper copy.

1. Include miscellaneous record submittals directory organized by Specification Section number and title.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect’s and College’s reference during normal working hours.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Demonstration and training video recordings.

B. Allowances: Furnish demonstration and training instruction time under the Demonstration and Training Allowance as specified in Section 012100 "Allowances."

C. Unit Price for Instruction Time: Length of instruction time will be measured by actual time spent performing demonstration and training in required location. No payment will be made for time spent assembling educational materials, setting up, or cleaning up. See requirements in Section 012200 "Unit Prices."

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Qualification Data: For instructor.

1.4 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.

D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

a. System, subsystem, and equipment descriptions.
b. Performance and design criteria if Contractor is delegated design responsibility.
c. Operating standards.
d. Regulatory requirements.
e. Equipment function.
f. Operating characteristics.
g. Limiting conditions.
h. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Operations manuals.
c. Maintenance manuals.
d. Project record documents.
e. Identification systems.
f. Warranties and bonds.
g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

   1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
   2. Owner will furnish an instructor to describe Owner's operational philosophy.
   3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

   1. Schedule training with Owner with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 017900

SECTION 018113 - SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED Gold certification based on USGBC's "LEED 2009 for New Construction & Major Renovations."

1. Other LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
3. A copy of the LEED Project checklist is attached at the end of this Section for information only.

B. Specific requirements for LEED are included in greater detail in other Sections.

1.3 DEFINITIONS

A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.

B. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect and the USGBC regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its determination on the project's LEED certification application. Document responses as informational submittals.

1.5 ACTION SUBMITTALS

A. General: Submit additional LEED submittals required by other Specification Sections.

B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

C. LEED Documentation Submittals:

1. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
2. Credit MR 4: Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating cost for each product having recycled content.
3. Credit MR 5: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
4. Credit MR 7: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
5. Credit EQ 3.1:

    a. Construction indoor-air-quality management plan.
    b. Product data for temporary filtration media.
    c. Product data for filtration media used during occupancy.
    d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.

6. Credit IEQ 3.2:

    a. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
    b. Product data for filtration media used during flush-out and during occupancy.
    c. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.

7. Credit IEQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
8. Credit IEQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
9. Credit IEQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For LEED coordinator.

B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:

1. Furniture.
2. Plumbing.
3. Mechanical.
4. Electrical.
5. Specialty items such as elevators and equipment.
6. Wood-based construction materials.

C. LEED Action Plans: Provide preliminary submittals within 14 days of date established for the Notice to Proceed indicating how the following requirements will be met:

1. Credit MR 2: Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
2. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
3. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
4. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
5. Credit IEQ 3.1: Construction indoor-air-quality management plan.

D. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:

1. Credit MR 2: Waste reduction progress reports complying with Section 017419 "Construction Waste Management and Disposal."
2. Credit MR 4: Recycled content.
3. Credit MR 5: Regional materials.
4. Credit MR 7: Certified wood products.

1.7 QUALITY ASSURANCE

A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated.

2.2 RECYCLED CONTENT OF MATERIALS

A. Credit MR 4: Building materials shall have recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content for Project constitutes a minimum of 20 percent of cost of materials used for Project.

1. Cost of post-consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
2. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.3 REGIONAL MATERIALS

A. Credit MR 5: Not less than 20 percent of building materials (by cost) shall be regional materials.

2.4 CERTIFIED WOOD

A. Credit MR 7: Not less than 50 percent (by cost) of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:

    a. Miscellaneous carpentry.
    b. Finish carpentry.
    c. Architectural woodwork.
    d. Wood paneling.
    e. Wood cabinets.

2.5 LOW-EMITTING MATERIALS

A. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.
2. Adhesives for Porous Materials (Except Wood): 50 g/L.
3. Carpet Adhesives: 50 g/L.
4. VCT and Asphalt Tile Adhesives: 50 g/L.
5. Cove Base Adhesives: 50 g/L.
6. Gypsum Board and Panel Adhesives: 50 g/L.
7. Rubber Floor Adhesives: 60 g/L.
8. Ceramic Tile Adhesives: 65 g/L.
9. Multipurpose Construction Adhesives: 70 g/L.
10. Contact Adhesive: 80 g/L.
11. Structural Glazing Adhesives: 100 g/L.
12. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine-covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
13. Top and Trim Adhesive: 250 g/L.

14. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
15. Other Adhesives: 250 g/L.
16. Architectural Sealants: 250 g/L.
17. Nonmembrane Roof Sealants: 300 g/L.
18. Other Sealants: 420 g/L.
19. Sealant Primers for Nonporous Substrates: 250 g/L.
20. Sealant Primers for Porous Substrates: 775 g/L.
21. Modified Bituminous Sealant Primers: 500 g/L.
22. Other Sealant Primers: 750 g/L.

B. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, paints and coatings shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Flat Paints and Coatings: VOC not more than 50 g/L.
2. Nonflat Paints and Coatings: VOC not more than 150 g/L.
3. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
5. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
6. Pretreatment Wash Primers: VOC not more than 420 g/L.
7. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
8. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
9. Floor Coatings: VOC not more than 100 g/L.
10. Stains: VOC not more than 250 g/L.

C. Credit IEQ 4.4: Composite wood, agrifiber products, and adhesives shall not contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT

A. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."

3.2 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

A. Credit IEQ 3.1: Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."

1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 015000 "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
2. Replace all air filters immediately prior to occupancy.

B. Credit IEQ 3.2: Comply with one of the following requirements:

1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. of outdoor air

per sq. ft. of floor area while maintaining an internal temperature of at least 60 deg F and a relative humidity no higher than 60 percent.

2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. of outside air or the design minimum outside air rate determined in Prerequisite EQ 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space.

3. Air-Quality Testing:

   a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "Green Building Design and Construction Reference Guide."
   b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:

      1) Formaldehyde: 27 ppb.
      2) Particulates (PM10): 50 micrograms/cu. m.
      3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
      4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
      5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.

   c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
   d. Air-sample testing shall be conducted as follows:

      1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
      2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
      3) Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
      4) Air samples shall be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION 018113

LEED for New Construction v2.2
Registered Project Checklist

3-Nov-11

Project Name: Montgomery College - New Bioscience Education Center
Project Address: Montgomery College, Germantown Campus

Yes	?	No			
3	9	2	**Sustainable Sites**		14 Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
1			Credit 1	**Site Selection**	1
	1		Credit 2	**Development Density & Community Connectivity**	1
		1	Credit 3	**Brownfield Redevelopment**	1
	1		Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
	1		Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
	1		Credit 4.3	**Alternative Transportation**, Low-Emitting & Fuel-Efficient Vehicles	1
	1		Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Site Development,** Protect or Restore Habitat	1
	1		Credit 5.2	**Site Development,** Maximize Open Space	1
	1		Credit 6.1	**Stormwater Design,** Quantity Control	1
	1		Credit 6.2	**Stormwater Design,** Quality Control	1
1			Credit 7.1	**Heat Island Effect,** Non-Roof	1
1			Credit 7.2	**Heat Island Effect,** Roof	1
	1		Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
4		1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

10	1	4	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required

*Note for EAc1: All LEED for New Construction projects registered after June 28th, 2007 are required to achieve at least two (2) points under EAc1.

8		2	Credit 1	**Optimize Energy Performance**	1 to 10
				10.5% New Buildings or 3.5% Existing Building Renovations	1
				14% New Buildings or 7% Existing Building Renovations	2
				17.5% New Buildings or 10.5% Existing Building Renovations	3
				21% New Buildings or 14% Existing Building Renovations	4
				24.5% New Buildings or 17.5% Existing Building Renovations	5
				28% New Buildings or 21% Existing Building Renovations	6
				31.5% New Buildings or 24.5% Existing Building Renovations	7
				8 35% New Buildings or 28% Existing Building Renovations	8
				38.5% New Buildings or 31.5% Existing Building Renovations	9
				42% New Buildings or 35% Existing Building Renovations	10
		1	Credit 2	**On-Site Renewable Energy**	1 to 3
				2.5% Renewable Energy	1
				7.5% Renewable Energy	2
				12.5% Renewable Energy	3
1			Credit 3	**Enhanced Commissioning**	1
		1	Credit 4	**Enhanced Refrigerant Management**	1
	1		Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

continued...

Yes	?	No			
7	1	5	**Materials & Resources**		13 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1
		1	Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
1			Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
		1	Credit 3.1	**Materials Reuse**, 5%	1
		1	Credit 3.2	**Materials Reuse**,10%	1
1			Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1
1			Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1
1			Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regiona	1
1			Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regiona	1
	1		Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1
Yes	?	No			
12		3	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
1			Credit 1	**Outdoor Air Delivery Monitoring**	1
		1	Credit 2	**Increased Ventilation**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems**, Lighting	1
1			Credit 6.2	**Controllability of Systems**, Thermal Comfort	1
1			Credit 7.1	**Thermal Comfort**, Design	1
1			Credit 7.2	**Thermal Comfort**, Verification	1
		1	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
Yes	?	No			
5			**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design**: Recycling has been attempted / User Ed is back-u	1
1			Credit 1.2	**Innovation in Design**: Green House Keeping	1
1			Credit 1.3	**Innovation in Design**: 95% MR2	1
1			Credit 1.4	**Innovation in Design**: WE 40%	1
1			Credit 2	**LEED® Accredited Professional**	1
Yes	?	No			
41	11	15	**Project Totals** (pre-certification estimates)		69 Points

Certified: 26-32 points, **Silver:** 33-38 points, **Gold:** 39-51 points, **Platinum:** 52-69 point

SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Commissioning requirements common to all Sections

B. Systems and equipment start-up and functional performance testing

C. Validation of proper and thorough installation of systems and equipment

D. Equipment performance verification

E. Documentation of tests, procedures, and installations

F. Coordination and requirements of training events

G. Preparation and logistics of Facility Manual content

H. Management of Record Construction Documentation

I. Sequencing

1.2 GENERAL DESCRIPTION

A. Commissioning (Commissioning) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority shall work with the Contractor and the Design Engineer to direct and oversee the Commissioning process and perform functional performance testing.

C. The Commissioning Plan outlines the commissioning process beyond the Construction Contract. The specification sections dictate all requirements of the commissioning process relative to the construction contract. The Commissioning Plan is available for reference at the request of the Contractor; however it is not part of the construction contract.

D. This Section and other Sections of the specification details the Contractor's responsibilities relative to the Commissioning process. It expands on the Commissioning Plan, which covers the roles and responsibilities of Parties outside of the construction contract.

1.3 SCOPE

A. This Section covers elements, requirements, procedures, and protocols common across all Divisions of the work. Requirements specific to individual Sections are generally specified in the technical specification for each division.

B. Specific systems to be commissioned are indicated in the following Divisions of the Specification:

1. Divisions 01: Conformance to the following provisions of the Commissioning requirements is required under Division 01 and this Section:

   a. Equipment and Systems Training as required by individual sections
   b. Facility Manual preparation and maintenance
   c. Record Document preparation and maintenance

2. Division 11 – Specialty Equipment
3. Division 14 – Conveying Equipment
4. Division 21 – Fire Suppression
5. Division 22 – Plumbing
6. Division 23 – HVAC including underground utilities
7. Division 26 – Electrical
8. Division 27 – Telecommunications
9. Division 28 – Security and Fire Alarm
10. Division 33 – Underground Utilities

1.4 RELATED WORK AND DOCUMENTS

A. Commissioning Plan: The Commissioning Plan outlines the commissioning process beyond the construction specification. All Contractor responsibilities are outlined in Specifications. Commissioning Plan is available to the Contractor to understand the context of their responsibilities but does not define any additional responsibilities of the Contractor

B. Section 013200 – Construction Progress Documentation: Stipulates the scheduling requirement related to the Commissioning process.

C. Section 013300 – Submittal Procedures: Stipulates additional copies of submittals to be submitted and refers to other sections for additional submittal requirements related to Commissioning.

D. Section 014000 – Quality Requirements: Specifies the requirements for construction quality control.

E. Section 015000 – Temporary Facilities and Controls: Specifies the requirements for using Owner's permanent equipment for temporary conditioning in the facility.

F. Section 017700 – Closeout Procedures: Stipulates Substantial Completion and Final Completion requirements and the basic terms of the construction warranty. It also stipulates Operation and Maintenance Documentation required

G. Section 017900 – Demonstration and Training: Defines the means and methods by which training programs shall occur.

H. Section 019113 – General Commissioning Requirements: details the Commissioning requirements common across all divisions

I. Section 019114 – Functional Testing Procedures: Outlines the generic functional testing procedures required.

J. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

K. Section 110800 – Conveying Equipment Commissioning: Details the commissioning procedures specific to Division 11 work.

L. Section 140800 – Conveying Equipment Commissioning: Details the commissioning procedures specific to Division 14 work.

M. Section 210800 – Fire Suppression Systems Commissioning: Details the commissioning procedures specific to Division 21 work.

N. Section 220800 – Plumbing Systems Commissioning: Details the commissioning procedures specific to Division 22 work.

O. Section 230800 – HVAC Systems Commissioning: Details the commissioning procedures specific to Division 23 work.

P. Section 230995 – Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.

Q. Section 260800 – Electrical Systems Commissioning: Details the commissioning procedures specific to Division 26 work.

R. Section 270800 – Telecommunication Systems Commissioning: Details the commissioning procedures specific to Division 27 work.

S. Section 280810 – Security Systems Commissioning: Details the commissioning procedures specific to the Security System work.

T. Section 280820 – Fire Alarm Systems Commissioning: Details the commissioning procedures specific to Fire Alarm System work.

U. Section 330800 – Utilities Commissioning: Details the commissioning procedures specific to underground utility work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Acceptance Phase: This is the phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and some final training occur. This will generally occur after the Construction Phase is complete (start-up and checks have been accomplished). The Acceptance Phase typically begins with certification by the contractor that the systems have been started up in accordance with the approved protocols and the submission of the documentation of that start up. The Acceptance Phase ends with either (the successful completion of all functional performance testing and sign off by the Commissioning Agent as well as the Owner.

B. Action Item (AI): Any issue that requires a response, completion, corrective or additional work, or any other action. Examples include a Request for Information (RFI), a work directive, a clarification request,

a to-do item, an identified deficiency, or any other like item. Action Items must be categorized as appropriate.

C. Action List: This is a list that is maintained and updated by the CA that includes all Action Items that relate to Commissioning activities.

D. A/E: General reference to the Architect/Engineer lead-design entity.

E. ASHRAE: American Society of Heating, Refrigerating, and Air Conditioning Engineers.

F. Automatic Temperature Controls Contractor (ATC): Contractor responsible for providing the Building Automation System and automatic temperature controls specified in fill in for specific project.

G. Basis of Design (BOD) Document: The Basis of Design document shall respond to, and be consistent with, the performance criteria specified in the Owner Project Requirements (OPR). The BOD illustrates the means by which OPR criteria are to be achieved, documenting the assumptions and parameters used in the design, and documenting the primary thought processes or decisions made that resulted in the selected alternatives.

H. Building Automation System (BAS): The computer-based control or automation system. May also be referred to as the FMS.

I. ComIT: Commissioning Information Tool, as software tool used for collaborative commissioning information management.

J. Commissioning (Commissioning): The process of ensuring that all building systems perform interactively according to the design intent, the systems are efficient and cost effective and meet the Owner's operational needs.

K. Commissioning Authority (CA): The Party retained by the Owner who will oversee the Commissioning process, develop and stipulate many of the Commissioning requirements, manage the Commissioning process, and ensure and validate that systems and equipment are designed, installed and tested to meet the Owner's requirements.

L. Commissioning Coordinator (CxC): This refers to the Individual within each of the various Parties that is designated the POC for that Party relative to Commissioning activities.

M. Commissioning Portal: This is an internet hub for the collaboration on Commissioning information. This portal will act as a hub for posting electronic information.

N. Commissioning Specifications ('Commissioning Specs'): Includes separate Commissioning specification sections and Commissioning-related subsections of other specifications. All Contractor requirements relating to Commissioning should be conveyed within the Commissioning Specs. Commissioning Specs should be referenced but not duplicated within the Commissioning Plan (which is designed to govern non-Contractor-related issues).

O. Commissioning Team (CxT): The group of Parties involved in the commissioning process for any given system. The Commissioning Team will include a core group involved with all systems. This core group will typically include the CA, the Owner's Commissioning Coordinator (O/O-CxC)] and the CM's Commissioning Coordinator (CM-CxC). On any given system, the Commissioning Team will also include the Commissioning Coordinator for the Contractor(s) responsible for the system or equipment.

P. Contractor: As used herein, 'Contractor' is a general reference to the installing Party and can therefore refer to the CM, subcontractors, or vendors as inferred by its usage.

Q. Construction Manager (CM): The party acting as the primary coordinator of all the major subcontractors (MC, EC, TAB, ATC, etc as applicable).

R. Construction Phase: Phase of the project during which the facility is constructed and/or systems and equipment are installed and started. Contractor and subcontractors complete the installation, complete start-up documentation, submit O&M information, establish trends, and perform any other applicable requirements to get systems started. Contractor and Vendors my also conduct equipment specific training. The Construction Phase will generally end upon completed start-up and TAB of systems and equipment.

S. Contract Documents: The documents governing the responsibilities and relationships between Parties involved in the design and construction of this project including (but not necessarily limited to):

1. Agreements/Contracts;
2. Construction Plans and Drawings;
3. Specifications;
4. Addenda;
5. Change Orders;
6. Commissioning Plan for reference only

T. Construction Documents: Refers generally to the Contract Documents that dictate the details of the installation (all but item 1. above).

U. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the

V. Electrical Contractor (EC): Contractor generally responsible for Div. 26 work

W. Facility Management System (FMS): Alternate reference to the computer based control or automation system. May also be referred to as automatic temperature control (ATC) system, direct digital control (DDC) system, building automation system (BAS), building management system (BMS), building management and control system (BMCS), digital control system (DCS), Energy Management System (EMS), Energy Management and Control System (EMCS) or System Control And Data Acquisition (SCADA) System.

X. Facility Manual: The Facility Manual is the final deliverable from the Commissioning process, and provides the information needed to understand, operate, and maintain the facility and its systems. It should be the repository of all updates and corrections as they occur (even through occupancy). The Facility Manual expands the scope of standard O&M documentation to incorporate additional information developed through the commissioning process. This is also often called a 'Systems Manual' throughout ASHRAE and LEED Commissioning references.

Y. Factory Authorized Representative: An individual fully trained on the equipment and certified by the manufacturer to perform the respective task.

Z. Factory Testing: Testing of equipment off-site at the manufacturer's facility. May be witnessed by members of the project team.

AA. Field Testing by Factory Authorized Representative: On site testing of equipment conducted by a factory authorized representative.

BB. Fire Alarm Contractor (FAC): Contractor generally responsible for the fire alarm system installation.

CC. Fire Suppression Contractor (FSC): Contractor generally responsible for the installation of the fire suppression system (sprinkler, standpipe, and fire pump) as specified in Div 21.

DD. Formal Hand Off Meeting: This is a quality control exercise in which all contractors responsible for completing the installation and start up of a system or equipment, along with the CA, Owner and CM, meet to validate that the system or equipment is completed per the contract documents and ready for functional testing, and that all the start up, verification, nameplate data, prefunctional checklists and testing documentation is complete and accurate to a functional state of completion. CM shall organize and lead the process in all cases.

EE. Functional Acceptance: A milestone that marks the completion of the Acceptance Phase and successful completion of the FPTs by the CA.

FF. Functional Performance Testing (FPT): The detailed and thorough testing of the building systems and the components and equipment making up those systems. References made to FPT throughout the documents are generally inclusive of ISFPT unless specifically indicated otherwise.

GG. General Contractor (GC): delete if CM used instead

HH. IAQ: Indoor Air Quality

II. Interactive System Functional Performance Testing (ISFPT): The detailed and thorough testing of the interactions of various systems in the building. ISFPTs are considered a subset of the overall concept of FPT and therefore references made to FPT generally will include ISFPTs unless specifically indicated otherwise.

JJ. Manufacturer's Representative: Either an individual in direct employ of the manufacturer of the applicable system, or an individual who is certified by that manufacturer to perform the applicable work for which the reference is made. This is synonymous with Factory Authorized Representative

KK. Mechanical Contractor (MC): Contractor generally responsible for Division 23 work

LL. O&M Documentation: When a full Facility Manual is not specified, this refers to Contractor-developed documentation designed to address the needs of facilities personnel and customized for the context of the specific facility and installation. The foundation of O&M Documentation is manufacturer's literature (including 'O&M Manuals', parts lists, troubleshooting guides, etc.) as well as Contractor-developed instructions for start-up and shut-down, sequences, and other installation-specific information. O&M Documentation content is a subset of the Facility Manual, so it is common for only one or the other to be specified.

MM. O&M Manuals: This term shall be reserved for referencing manufacturer-published O&M documents, which generally has no information specific to the specific facility. Specifications should strive for this information to be submitted in electronic form whenever possible.

NN. Opposite Season: The season opposite that when the majority of the testing occurs.

OO. Owner/Operator (O/O): This is a combined reference to the both the Owner and the operators of the facility

PP. Party: Entity legally responsible for portion of work.

QQ. Point of Contact (POC): General reference to the key individual within each Party.

RR. Pre-Test: Preliminary testing accomplished to verify system functionality prior to placing the system/equipment into preliminary service.

SS. Project Phases: Phases of the project include the Construction Phase, Acceptance Phase, and Warranty Phase

TT. Project Officer (PO): Individual or entity directly employed by the Owner who is in charge of the design and construction coordination for the project.

UU. RFI: Request for Information

VV. Scheduled Outage: A period of time, scheduled by Owner, in which the system is out-of-service or not to be used by occupants.

WW. Start-Up: Refers to the quality control process whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the Start-Up Checklist, energizes the device, verifies that it is in proper working order and ready for dynamic testing, and completes the Start-Up Tests.

XX. Start-Up Checklist Item: A list of items to inspect to verify proper installation of equipment or systems by the Contractor. Checklist items simply require a 'Yes/No' or 'OK/Not' response. These include primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension checked, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). Start-Up Checklist items are one component of the Start-Up Procedures (Start-Up Tests being the other).

YY. Start-Up Procedures: Refers to the combination of Start-Up Checklists and Start-Up Tests. Start-Up Procedures are typically performed by the Contractor with or without a formal Commissioning process. The Contractor documents the start-up process by completing and submitting the Start-Up Procedures. Start up procedures may be a combination of those prepared by the CA, those performed included in the contractor's quality assurance process, and those required by the manufacturer. Regardless of the context of the checklist or format of the form used to documents it, the reference to Start Up Procedures includes all of the stated procedures.

ZZ. Start-Up Test: This is a test that may be involved with equipment start-up. It differs from a checklist item in that it requires more than a binary (yes/no, OK, Not OK) response - an observation, measurement, or sequence of events must be documented. Start-Up Tests are one component of the Start-Up Procedures (Start-Up Checklists being the other).

AAA. Substantial Completion: As defined in the Owner-Contractor agreement. This milestone will coincide with the Functional Acceptance of the systems. This milestone also coincides with the start of the warranty period.

BBB. TAB: Can refer to the test, adjust, and balance process or the Testing, Adjusting, and Balancing Contractor.

CCC. Testing Agency: An independent agency typically retained by the Contractor to perform specialized testing of systems or equipment (most commonly electrical). The Testing Agency shall be qualified and equipped to perform the testing and shall submit appropriate qualifications.

DDD. Trending: Monitoring and recording a history of parameters typically using the building automation system.

EEE. Vendor: Refers to the organization that sold a system or equipment to the subcontractor. This may be a branch office of the manufacture or a value added reseller.

FFF. Warranty Period: the period defined by the construction documents where elements of the facility are under contractual warranty

GGG. Warranty Phase: Includes the early occupancy of the building and can continue through the contractual Warranty Period and at least into the opposite season from when the facility systems were initially tested

1.6 REFERENCE STANDARDS

A. ASHRAE Guideline 1-1996, "Guideline for Commissioning HVAC Systems"

B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”

C. NEBB - Procedural Standards for Building Systems Commissioning

1. ASHRAE Standard 110 – Method for Testing Laboratory Fume Hoods

D. NSF 49 – Class II Biosafety Cabinetry

E. USGBC - LEED NC 3.0 Reference Package

F. SMACNA IAQ Guidelines for Occupied Buildings under Construction

1.7 DOCUMENTATION

A. Contractor shall provide to the Commissioning Authority the following per the procedures specified herein and in other Sections of the specification:

1. Shop Drawings and Product Data: CA shall be provided shop drawings and submittal data for systems and equipment that will be part of the Commissioning process. Some of these submittals will be reviewed by the CA and others are only needed for record. CA will mark up the Submittal Register to indicate what is required.

a. Submittals to be Reviewed: CM shall provide the CA one electronic copy of Shop Drawings and Product Data concurrent with distribution to the A/E. Commissioning Authority shall review and incorporate comments via the Design Engineer. CM shall then copy CA with the reviewed submittal with A/E approval stamp.
b. Submittals for Record: CM shall provide to the CA the final electronic record copy of the submittal.

2. Draft Start-Up Procedures: Contractor shall assist in development of Start-up Procedures for all applicable equipment and systems along with the manufacturer’s application, installation and start-up procedures. CA will initially provide to the Contractor generic Start-up Checklists, the content of which must be reviewed by the Contractor and supplemented with manufacturer-specific

requirements and the Contractor's own internal quality assurance procedures and checks. CA will review draft and recommend approval.

3. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase.
4. Schedule Updates: Issue periodic updates to the construction schedule as specified. Provide electronic copy of each update to the CA. Contractor shall use schedule to notify Commissioning team of scheduled start-up and training activities.
5. Temporary Conditioning Plan: Contractor shall provide initial Temporary Conditioning Plan for approval and then issue periodic updates to reflect actual conditions. At the completion of the Temporary Conditioning, the final plan shall be submitted with completed maintenance records, inspection and check logs, operating logs, etc.
6. Action Item Response: Respond to Action Items to which Commissioning team members assign the Contractor responsibility.
7. Field Testing Agency Reports. Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase.
8. Completed Start-Up Procedures: Completed Start-Up Procedure documentation for all applicable equipment and systems. Provide prior to the start of the Acceptance Phase. CA will review prior to FPT.
9. Nameplate Data Documentation: Provide prior to the start of the Acceptance Phase.
10. Equipment Warrantees: Provide prior to the start of the Acceptance Phase.
11. Training Plan: Provide prior to the start of the Acceptance Phase.
12. Record Training Documentation: Provide at least 7 days prior to the start of the applicable training session. The compiled and final record training documentation will be provided by the CM within 14 days of the last training session provided under the construction contract (this will typically be the site specific controls training). This will take the form of the Training Plan supplemented with evaluations and actual dates and topics.
13. O&M Manual Content: Provide O&M Manual content per the requirements of this section, and Division 1 requirements. Submit at least one month prior to the beginning of the Acceptance Phase.

1.8 COMMISSIONING SEQUENCING AND SCHEDULING

A. Refer to the sequencing illustration at the end of this Section for a conceptual graphical representation of the precedents related to the Commissioning tasks. These precedents are generally to be applied per system and/or per area. Where applicable, in order to expedite the close out of the facility, various systems can be in various stages of the commissioning process. CA and Contractor shall cooperate to schedule the Commissioning tasks to minimize the duration of the Commissioning activities.

B. The Commissioning will be categorized into Phases as indicated below and defined under the definitions paragraph above. Note that per schedule, different systems and/or areas may be in different phases at any given time given that the Commissioning and testing process will be integrated into the construction process:

1. Construction Phase:
2. Acceptance Phase:
3. Warranty Phase:

C. CA will provide a more detailed precedent diagram in Gantt chart OR Excel format for direction of Commissioning precedents and task duration.

D. Prior to submission of the baseline schedule, Scheduler will coordinate with the Commissioning Authority to specifically include the detailed tasks involved in the commissioning (Commissioning) process. Commissioning Authority will provide an initial "Precedent Diagram" that outlines the optimal

commissioning process. Scheduler shall meet with the Commissioning Authority and the subcontractors to synthesize the Precedent Diagram with the general construction process constraints and integrate the agreed upon process into the main construction schedule. Commissioning related tasks shall be coded as such to facilitate generating a Commissioning fragnet that will be used during commissioning progress meetings.

E. The Commissioning Precedent Schedule will outline generic Commissioning tasks with precedents or prerequisites to each task. These tasks, which will be shown generically for typical systems, will apply to many systems. Contractor shall incorporate the tasks into EACH SYSTEM. This will require a detailed track for each system and as such the scheduler must schedule and code by system as well as area. The Commissioning precedent diagram will also indicate system precedent requirements for start-up and acceptance testing. Contractor shall collaborate with the CA to determine impacts of project phasing as applicable. Examples of enumerated tasks include:

1. Preparation of draft Start-Up Procedures
2. Contractor preparation of Training Plan
3. Preparation of Facility Manual content
4. Testing Agency activities
5. Electrical Start Up by system and zone group
6. Mechanical Start Up by system and zone group
7. Controls Start Up by system and zone group
8. TAB by system and zone group
9. Training Events
10. Functional Testing by system and zone group
11. Occupant or Regulatory Agency testing or approval process

F. Contractor shall completely install, thoroughly inspect, start-up, test, adjust, and balance systems and equipment. All activities shall be documented per specified procedures and progress tracked on the construction schedule. Contractor shall notify A/E, Owner, and CA in writing that systems are complete and ready for verification and functional performance testing. CM shall schedule and conduct Formal Witnessed Start Ups of all systems and equipment in the Commissioning scope as specified below.

G. Contractor shall notify CA at least 14 days in advance of any tests, start-ups, or training. CA shall witness selected tests and start-ups. Notification shall be accompanied by a schedule showing the coordinated start date and task duration and all currently open precedent requirements.

H. Notification of utility or system outages affecting current mission shall require advance notification per applicable Division 01 section.

I. Connections to or Interruptions of Existing Systems: Where the project entails connection to or interruption of existing functional systems that are supporting the Owner's mission, such connection activities must be shown as a milestone on the project schedule. Generally these connections will require extensive coordination and a long period of pre-notification as defined in Division 01. Owner will not accept these connections unless the connection or outage is shown as a milestone 3 months prior to the event. The schedule will not be required to pinpoint the day and time 3 months in advance, however, it shall have been accurate to +- 2 weeks. The actual notification of the exact day and time shall be processed per applicable Division 01 section.

1.9 FORMAL HAND-OFF MEETINGS

A. CM shall schedule and conduct Formal Hand–Off Meetings (FHOM) - of all systems and equipment. This is a Contractor Quality Control exercise to validate that the systems and equipment are ready for Functional Performance Testing and complete to the point represented on the start-up and prefunctional

checklists. It is not intended to be a test although spot checking and validation may occur. The FHOM is not the act of starting up systems, it is the QC validation that the systems have been started to a high standard of care, the systems are complete and ready sufficiently for the functional test, and the start up and functional test is accurate. The FHOM should involve the responsible subcontractors and vendors, and their contractually superior entities up to the CM.

B. Notification shall be given of all FHOMs via an Action Item posted on the Portal at least two weeks in advance of the activity. CA and Owner shall be notified and may witness these however the primary responsibility of confirmation of the represented state of the equipment lies with the CM.

1.10 ELECTRONIC RECORD SUBMITTALS

A. Within 14 calendar days after receipt of approval from Owner and the Architect on any submittal, for equipment that is scheduled to commissioned, Contractor shall submit a final electronic version of the submittal for Owner's future asset management. These will also be incorporated into the Final electronic O&Ms provided by the Contractors.

B. Final electronic submittals shall:

1. Be originally authored in electronic media and not scanned versions with hand mark ups unless specifically approved otherwise.
2. Be provided in Portable Document Format (*.pdf) with selectable text and graphics that are readable. Generally the documents shall be merged into one bookmarked document up to 500 mb. Merged documents shall use hierarchical bookmarks to form a table of contents and provide hyperlinks to the subject topic. For submittals larger than 500 mb, provide a summary document in PDF or HTML format with relative hyperlinks to the associated document files within the same directory or in directories subordinate to the summary document.
3. Include all final ratings, parameters, specifications, options, etc. In the case where the Architect returns the submittal "Approved As Noted, Resubmission Not Required" and includes mark-ups or comments that change the originally submitted ratings, parameters, specifications, options, etc., the Contractor shall correct the documents in the original electronic document prior to submitting the final electronic documents.
4. Highlight the specific rating, parameter, specification, option, etc. when the original document includes multiple alternatives. For instance when a range of performance parameters are given, various sizes are shown, or various options are listed, the applicable item shall be indicated by highlight, circle, pointer, etc.
5. Not necessarily include generalized direction from the Architect that does not related to ordering and purchasing the equipment. For instance, notes like, coordinate with xxx for final motor horsepower are not to be transferred to the electronic submittal. In that example only the final coordinated sizes would be indicated.

C. Final Electronic Submittals shall be either posted to the project web site or provided on compact disc.

1.11 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Commissioning are initially defined below but will be refined and documented in the Construction Phase Commissioning Kick Off meeting. Contractor shall have input in the protocols and all parties will commit to process and scheduling obligations. The CA will record and distribute.

1. Submittals and Shop Drawings: CM shall distribute these to the CA. CA shall edit the Systems Matrix to communicate which submittals must be forwarded.

2. CA Review Comments on Shop Dwgs: Posted on the electronic forum and a copy sent directly to the A/E and Owner PO by the CA. A/E to consider and incorporate at their discretion.
3. Deficiencies Identified by the CA: When the CA identifies a deficiency, CA shall make a good faith assessment of responsible parties. Those parties and the Cx Team shall be notified of the perceived deficiency. This communication is FOR INFORMATION ONLY and is not a direction of resolve the deficiency. Contractor may accept responsibility and resolve the deficiency voluntarily. If contractor contests either the deficiency or responsibility for that deficiency, Contractor shall respond to that deficiency indicating disagreement. If responsibility is not agreed to via the Commissioning dialogue, CM shall issue a work directive or RFI via the normal contractual channels to resolve the issue.
4. Requests for Meetings: In general request by the contractor for a meeting with the CA shall be routed through Owner PO who will then determine the validity. Note that every attempt should be made to deal with Commissioning issues at Commissioning Meetings.
5. Control Sequence Modifications: CA shall make every attempt to thoroughly review the sequences during the submittal phase and address any issues prior to the submittal approval. However, CA and the ATC may incorporate minor changes to the sequence during testing when it is apparent that it improves the control of the equipment but does not fundamentally change the sequence. The time required by the ATC for this type of modification is addressed in Section 230800. Any and all changes must be thoroughly documented in the record documents.
6. Scheduling Coordination – CA shall consult directly with the CM to incorporate the Commissioning tasks in the project schedule. The process logic and integration shall ultimately be a collaboration between CM, CA, and subcontractors. The effort will start with CA and CM proposing initial logic. Then sub contractors will join the discussion and work out the final details, (precedent logic and durations).
7. Notification of Completion Milestones – Contractor shall notify Owner at least two weeks prior to an anticipated commissioning activity or commissioning milestone (such as ready for FPT). CM CxC shall then coordinate the scheduling of the activity (as applicable) between all required parties as applicable. Notification shall be posted using the Commissioning Portal Events Module with an associated Action Item distributed to interested parties.
8. Action List: CA maintains a categorized Action List which tracks the Commissioning related action items. All content of the Action List will be available to all parties who have credentials on the portal. Any party with credentials may post an Action Item. Any party that is copied on an email resulting from an Action Item posting may respond to it and contribute to the dialogue.
9. Start Up Checklist and Test Documents: CA will provide initial “generic” start up checklists to the contractor. The contractor shall review these with respect to the manufacturer specific start up procedures and provide comments for the CA to update and post final, vendor specific checklists. The Contractor then performs the approved Start-Up procedures and enters the results on the Project Portal. CxT subsequently spot checks the procedures and documentation. They are then included in the Commissioning Record
10. Functional Performance Test Documents: Functional performance tests are prepared and completed by the CA. They are developed during the construction phase generally after completed submittals. CA forwards the FPT procedures to the CM to be subsequently distributed by them to the subcontractors for review. Contractors approve the procedures. Throughout the Commissioning process, CA maintains a current record of the testing procedures and keeps the documentation up to date and accessible for all to access the current progress.

1.12 CONTRACTOR RESPONSIBILITIES

A. Construction Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Construction Phase.

1. Include Commissioning requirements in price and plan for work.

2. Designate a Commissioning Coordinator (CxC) from each major subcontractor with activities related to commissioning. These Commissioning Coordinators are to be the primary contacts for Commissioning activities.
3. Attend Construction Phase Commissioning Kick Off Meeting. The Commissioning Coordinator and Project Manager from each major subcontractor shall attend.
4. The Commissioning Coordinator shall attend all Commissioning progress meetings unless otherwise agreed to by the CA.
5. Remedy any deficiencies identified throughout construction.
6. Review draft Start-Up Procedures and comment with respect to Vendor Specific start-up requirements.
7. TAB shall submit sample balancing forms for approval prior to starting work.
8. Schedule and coordinate Commissioning efforts into the construction schedule. Incorporate the precedent diagram provided by the CA into the construction schedule. Indicate at a minimum all tasks enumerated on the precedent diagram for all systems.
9. Coordinate the work of subcontractors, vendors, manufacturers, and Testing Agencies provided with the bid, and ensure that they are informed of and are adhering to the requirements of the Commissioning process specified throughout the contract documents. Particular reference is made to providing the required O&M Documentation; to submittal of training materials and documentation of that training; to collaboration with the overall start-up and testing process; to developing comprehensive integrated procedures for scheduling and task notification and documenting them in a common format; and to electronic delivery requirements if applicable.
10. Develop and submit Temporary Conditioning Plan
11. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
12. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this section.
13. Start-up, test, adjust, and balance systems and equipment prior to verification and performance testing by the Commissioning Authority. Start-up procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically individual Commissioning specifications. Provide skilled technicians qualified to do the work required. Provide factory trained/authorized technicians where required by the contract documents and stated in the applicable technical section. Generally start up and testing shall proceed from device checkout, to component checkout, to system checkout, to inter-system checkout.
14. Prepare spaces with adequate security for onsite contractors to store equipment. Provide secure space with 120 volt AC power for the CA, TAB, and ATC to base their operations and store test equipment, drawings, files, and the like.
15. Schedule for representative space mock ups as early as possible to facilitate determining standards for close out
16. Record start-up and testing procedures on start-up forms or checklists and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the party actually performing the task or procedure.
17. Provide skilled technicians qualified to perform the work required.
18. Provide factory-trained and authorized technicians where required by the Contract Documents.
19. Record Start-up Procedures on start-up procedure forms on the Project Portal and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.
20. Tag equipment that is started with the Individual's name and date.
21. Demonstrate the operation of all systems as specified.

22. Certify that systems have been installed and are operating per Contract Documents prior to Functional Performance Testing.
23. Maintain an updated set of Record Documentation as required by the Contract Documents.
24. Copy the CA on indicated documentation.
25. Conduct and document Equipment and Systems Training events as required by this Section and Section 01 7900, and by applicable sections of the Specifications pertaining to each piece of equipment or system.

B. Acceptance Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Acceptance Phase.

1. Assist CA in functional performance testing. Assistance will generally include the following:

    a. Manipulate systems and equipment to facilitate testing (as dictated in Section 019114 ; in most cases this will entail only an initial sample).
    b. Provide any specialized instrumentation necessary for functional performance testing. Instrumentation outside of that required to complete the work will not be required.
    c. Manipulate BAS and other control systems to facilitate functional performance testing (as dictated Section 019114; in most cases this will entail only an initial sample).

2. Correct any work not in accordance with Contract Documents.
3. Participate in Training Events relative to use of O&M information and the PM program.
4. Maintain record documentation, and update and resubmit it after Functional Completion.
5. Compensate CA for additional site time incurred due to incompleteness of systems or equipment at time of Functional Performance Testing.

C. Warranty Phase: The following delineates the commissioning-related responsibilities of the Contractor (and their subcontractors) during the Warranty Phase.

1. Provide warranty service;
2. Conduct BAS Sequence Training
3. Respond to and document Warranty issues
4. Participate as required in the opposite season testing;
5. Correct any deficiencies identified throughout the Warranty Phase;
6. Update record documentation to reflect any changes made throughout the Warranty Phase and resubmit final Record Drawings at the close of the Warranty period.

1.13 EQUIPMENT SUPPLIER/VENDOR RESPONSIBILITIES

A. Construction Phase: The following delineates the commissioning-related responsibilities of the Equipment Supplier (and their subcontractors) during the Construction Phase.

1. Provide shop drawings and product data in hard copy and electronic format.
2. Provide manufacturer's application, installation and start-up instructions within 30 days of shop drawing/product data approval.
3. Where factory-authorized start-up is specified, coordinate and participate in the specified commissioning process and document start-up on the appropriate forms.
4. Review and approve Functional Test Procedures affecting supplied equipment.
5. Where training is to be provided by factory-authorized personnel, provide required Training Plan information including course content for approval prior to conducting the training.
6. Conduct and document Equipment and Systems Training events as required by this Section and Section 01 7900, and by applicable sections of the Specifications pertaining to each piece of equipment or system.

7. Provide spare parts and materials as required by Specifications.
8. Provide special tools as required by the Specifications.
9. Provide Facility Manual content as required and develop project-specific O&M content as required by the Commissioning requirements.
10. Provide all warranties.

B. Acceptance Phase: The following delineates the commissioning-related responsibilities of the Equipment Supplier (and their subcontractors) during the Acceptance Phase.

1. Participate in any Functional Testing Procedures required.
2. Consult on issues identified relative to the supplied equipment.

C. Warranty Phase: The following delineates the commissioning-related responsibilities of the Equipment Supplier (and their subcontractors) during the Warranty Phase.

1. Provide any warranty service required to the supplied equipment as applicable with the agreement with the Contractor.
2. Maintain Facility Manual content relative to supplied equipment.
3. Provide technical support to the Owner's facilities personnel.

1.14 COMMISSIONING KICK OFF/COORDINATION MEETING

A. CA shall schedule and conduct a Commissioning coordination meeting near the beginning of construction. The following should be discussed at this meeting:

1. The Commissioning Documents
2. Requirements and Sequence of Commissioning
3. Responsibilities of the construction parties
4. Management protocols
5. Required submittals
6. Schedule

1.15 START-UP PROCEDURES AND DOCUMENTATION

A. Purpose: The Commissioning process requires that the normal quality control processes involved with preparing systems and equipment for operation are performed to a high standard of care and are thoroughly documented. The required commissioning-related Start-Up Procedures involve nothing additional than that which would be done for any good installation. These procedures shall be performed to all installed systems and equipment and no sampling strategy is used for the start-up process. The Commissioning process requires all Parties to collaborate to establish the optimal standard of care for starting systems and equipment. After the procedures are established, the Contractor performs them and documents them with the Start-up Procedures that are developed by the joint effort of the Contractor and the CA.

B. Manual Creation of Start-up Procedures: Start-up Procedures (consisting of checklists and tests as above) for each type of equipment and system shall be created by the CA and reviewed by the Contractors prior to start-up. These may be supplemented with Vendor – specific start-up forms when approved by the CA.

C. 'Generic' Start-Up Procedures: Refer to respective Cx specifications for generic Start-up Procedures for a variety of mechanical and electrical systems. The content of these Start-Up Procedures shall provide the minimally acceptable content. Prefunctional documentation will be created by the CA. Generic

refers to the fact that the protocols may be created before the shop drawings are finalized. These procedures and protocols will be those common across different manufacturers.

D. Content of Start-Up Procedures: Start-Up Procedures shall generally include the following for each item of equipment or system (as applicable):

1. Project-specific designation, location and service
2. Indication of the Party performing and documenting the Start-Up Procedure
3. Clear explanation of the inspection, test, measurement, and outcome with a Pass/Fail indication and a record of measure parameters
4. Include a checklist item indicating that all O&M instructions, Warranties, and Record Documents have been completed and submitted
5. Include a Start-up Checklist item indicating that proper maintenance clearances have been maintained
6. Include a Start-up Checklist item indicating that special tools and/or spare tools required for normal operation and maintenance were turned over to the Owner
7. Include Start-up Checklist item indicating that all required dependent or prerequisite equipment and systems were previously started successfully

E. Manufacturer's Requirements: Start-up Procedures shall incorporate all manufacturer-specified procedures. As applicable, include acceptance criteria specified therein. The manufacturer's start-up and checkout procedures shall be submitted to the CA along if they are to supplement the CA generated forms.

F. Recording and Documentation of the Start Up: Manufacturer's start up protocols shall be executed and forms shall be completed by a qualified/authorized technician. These shall either be produced electronically or shall be scanned and submitted electronically. Electronic documentation of Manufacturer's recommended start up shall be linked into the applicable test in ComIT.

G. Recording and Documentation of Prefunctional Checklists and Tests: Generally in concert with the start up process, the ComIT prefunctional tests and checklists shall be completed by a qualified technician. The information contained in the checklists is the minimum amount of information that will be completed in the database. Even if the information is contained in the manufacturer's start up checklists, it shall be entered for reference in the prefunctional documentation completed in ComIT. The completed documentation shall be presented and reviewed at the Formal Witnessed Start Up

H. Related Sections and Contract Documents: Refer to the technical specifications and commissioning-related Sections for additional information.

I. CA Review: CA shall review the draft Start-Up Procedures and request any additional information required to meet the Commissioning criteria. CA will also review and spot-check procedures during Functional Performance Testing.

J. Documentation Completion: The individual executing the startup must complete the start up and prefunctional documentation for any given equipment and acknowledge acceptability with the indication of who did the associated task. As approved by the CA, in some cases the subcontractor as opposed to the manufacturer's start up technician may complete the prefunctional information in ComIT. Whether done on paper in the field or done directly into the computer, all data shall be entered into the project database.

K. Sampling and Final Submission: All (100% of) systems are started and documented per the approved procedures and NO sampling strategy is used. Completed Start-up and prefunctional checklists for all pieces of equipment shall be submitted to Commissioning Authority prior to any associated functional

performance testing. Any outstanding item shall be clearly indicated and an associated Action Item must be entered to track resolution.

L. Owner Access: Contractor shall allow access by Owner representatives to inspect the equipment and ensure its proper operation. Owner will be allowed to affix service tags to equipment to track the proper maintenance.

1.16 FUNCTIONAL PERFORMANCE TESTING

A. The objective of Functional Performance Testing is to demonstrate that each system is operating according to the documented Design Intent Document and Contract Documents. Functional Performance Testing facilitates bringing the systems from a state of Substantial Completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

B. The logistics and procedures involved in Functional Performance Testing are outlined below and in Section 019114.

1.17 DEFICIENCIES IDENTIFIED DURING FUNCTIONAL TESTING

A. Non-Conformance. Non-conformance deficiencies identified during Functional Performance Testing shall be resolved as follows:

1. The CA will record the results of the functional test in the ComIT project database. All deficiencies or non-conformance issues shall be noted as Action Items and reported to the Owner and Contractors.
2. Corrections of identified minor deficiencies may be made during the tests at the discretion of the CA. In such cases the deficiency and associated resolution will be documented in the database.
3. Every effort will be made by the CA to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.
4. As tests progress and deficiencies are identified, the CA will discuss the issue with the executing Contractor.

    a. When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it:

        1) The CA shall document the deficiency along with the Contractor's response and intentions, and they go on to another test or sequence. A copy/email of the deficiency shall be generated and provided to the Contractor and CA. The Contractor corrects the deficiency, completes the Action Item response certifying that the issue is resolved and /or the equipment is ready to be retested, and sends it back to the CA.

        2) The CA reschedules the test and the test is repeated.

    b. If there is a dispute about a deficiency, regarding whether it is a deficiency and/or who is responsible:

        1) The deficiency shall be documented as an Action Item with the Contractor's response and the CM will be notified. The CM will track this issue under the construction contract dispute resolution provisions.

        2) Final interpretive authority is with the A/E. Final acceptance authority is with the Owner.

3) The CA documents the resolution to the Action Item.

4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, and responds to the Action Item indicating completion. The CA reschedules the test and the test is repeated until satisfactory performance is achieved. CA then closes the Action Item.

B. Cost of Retesting: The cost for the CA to retest a Start-up or Functional Performance Test shall be paid by the Contractor responsible for the deficiency. Owner shall pay the CA directly and back charge the responsible Contractor.

C. Failure Due to Manufacturer's Defects. If 10% or three, whichever is greater, of identical pieces of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, all identical units may be considered unacceptable by the DM. (For the purposes of defining 'identical equipment' for this Section, size or capacity alone does not constitute a difference.) In case of failure due to manufacturer's defects, the Contractor shall provide the Owner with the following:

1. Manufacturer shall respond in writing as to the cause of the failure and proposed resolution.
2. Manufacturer shall implement their proposed resolution on a representative sample of the product.
3. The Owner will determine whether a replacement of all identical units or a repair is acceptable.
4. Upon acceptance, the manufacturer shall replace or repair all identical items at their expense and shall extend the warranty accordingly (if the original equipment warranty had begun).
5. Manufacturer shall pay the costs of all retesting necessitated by the failure.

1.18 TRAINING EVENTS

A. General: Adequate and thorough training of the Operators and the facilities staff is vital to effective transition and early occupancy of the building. A key goal of the Commissioning Team is to ensure that this is accomplished. Contractors, Subcontractors, and Manufacturers/Vendors as specified shall prepare and conduct training sessions on the installed systems and equipment for which they are responsible. The Contractor shall be responsible for insuring all training is performed in accordance with the Contract Documents.

B. Training Plan Document

1. The Training Plan shall outline the Training Events as proposed by the Contractor, and shall be approved by the CA. Training Plan shall summarize all equipment and systems-related training events with topics to be covered and approximate training duration.
2. The Training Plan shall include at a minimum:

a. Topic and applicable specification section;
b. Scheduled date(s) for the Events(s);
c. Location and setting (classroom or field);
d. Lead instructor and instructors qualifications;
e. Co-instructors and their qualifications;
f. Training objective;
g. Event outline/agenda;
h. Detailed breakout of content to be presented;
i. Anticipated duration;
j. Required attendees for each session.

3. Review: CM shall compile the individual training agendas of the subcontractors and vendors and submit a comprehensive Training Plan to the CA, Architect and the Owner for review. Contractor shall incorporate comments and requirements resulting from the review and resubmit the Training Plan prior to conducting any training sessions.

C. Training Prerequisites: Training shall not be conducted until the subject system or equipment is operating properly and after it has been successfully started per the commissioning requirements. If Contractor wishes to schedule both Start-Up and Training on the same day/visit, Contractor shall allow enough time to fully start-up and document start-up of the systems. If the systems are not fully functioning, training will be canceled and rescheduled.

D. Record Training Documentation: The Contractor must document all training sessions. Beyond that included in the Training Plan, documentation shall include the names of the attendees. Training shall follow handouts that list at a minimum the key points in bullet-form presentation style, and presentation handouts shall be provided even when training follows detailed written documentation. Training will not be approved unless it contains accompanying written documentation.

E. Video Documentation: The Contractor must record all training sessions as noted in specifications.

1.19 O&M MANUAL CONTENT AND ORGANIZATION

A. Preliminary submission of the draft O&M manual shall be made within 30 days of completion of the final approved submittal, but prior to the Acceptance Phase of the project.

B. The format of the electronic O&M shall be as described above for the electronic record submittals.

C. Final submission of the O&Ms shall be as defined in applicable specification section.

1.20 TEMPORARY CONDITIONING

A. Contractor shall only use building permanent equipment to provide temporary conditioning on the approval of the AE, Owner, and the CA. Approval for such will only be given upon acceptance of a detailed plan provided by the individually involved subcontractors and compiled by the CM. The temporary conditioning plan shall be a required element of the Construction IAQ Management Plan required for the LEED Credit IEQ 3.1. The temporary conditioning plan shall consider/address the following at a minimum

1. Indicate that the full start up protocol as required by the specification for final acceptance will be performed for the temporary start up. Temporary conditioning plan shall include the start up forms to be used which will be the same as those that will be used for final start up.
2. Contractor shall address how equipment will be maintained in good, clean condition. Specifically address:

    a. Temporary filtering of air: Air Filters used for construction shall be at least that specified for final use. Contractor shall remove construction filters and replace with new filters at substantial completion. Filters shall be maintained and replaced at the specified final pressure drop. Contractor shall install a magnehelic for visual indication of pressure drop as well as set up the loaded filter DP switch for monitoring on the BAS.
    b. Temporary Filtering of Water and Condensate: Construction strainers shall be used while circulating fluid during construction. Strainer shall be finer than specified for final strainers.

c. Sealing/Filtering of Open Ducts: Address that all open ducts shall be either sealed or protected with filter media. Generally return or exhaust systems shall not be used during construction unless otherwise approved.
d. Lubrication and Maintenance: Contractor shall maintain the systems and equipment in accordance with the manufacturer's instructions. Contractor shall coordinate lubricants used with Owner's operators. Frequency of lubrication and inspection shall be as recommended by manufacturer's literature. Applicable maintenance lubrication schedules shall be included in the plan. Draft maintenance logs shall be submitted with plan and completed as maintenance is performed.
e. Operation outside of Normal ranges: Systems and equipment shall not be operated outside the range of specified conditions. Plan shall address how the contractor will ensure that operation will not harm the equipment
f. Emergency Condition Identification and Response protocols: Plan shall address protocols for responding to equipment malfunctions and or harmful operation. Automatic safeties and remote enunciation shall be in place to protect people and property. Temporary operation shall not be allowed until there is an automatic communication/enunciation medium such as a phone connection or an internet connection. At a minimum, an alarm on the equipment used for temporary service shall be automatically sent to the contractor's 24 hour monitoring service and to the Owners' help desk. The contractor shall respond to and be responsible for securing conditions within the building. Owner shall assess the situation and as necessary secure utilities feeding the building from isolation points outside of the building.

3. Campus Utility Impact: The plan shall address the expected impact on the campus utilities involved in the temporary conditioning equipment. Specifically address:

   a. How the systems will be controlled to both ensure they are operating in range, and to avoid energy waste or inefficient conditions.
   b. Project the range of loads and flows to be imposed on the campus systems. For cooling, indicated how you will ensure a temperature split of at least 8C.
   c. For campus chilled water connections, the bridge connection and automatic control of the bridge related sequences shall be installed, functional and tested.

4. Building Protection: Address how the system will be controlled to avoid humidity conditions that will either promote mold growth or cause corrosion.
5. Equipment Reconditioning: Address with specific means and methods how the equipment used for temporary conditioning will be re-conditioned to new condition. Belts, seals, bearings, couplings, or other parts that wear more than 3% of their expected life shall be replaced.
6. Cleaning: Address how ducts, pipes, coils, converters, air handling equipment, terminal units, etc. shall be cleaned at final turn over.
7. Operations Log: Contractor responsible for operating the equipment shall maintain a log of all activities associated with operating and maintaining equipment. Log shall be submitted to Owner on a frequency specified by them.
8. Operating System Alterations: Plan shall address specific protocol for doing work the systems
9. Any material, device, component, equipment, etc. that is assessed as damaged or as having a substantially shortened life as a result of temporary conditioning operation shall be replaced by the contractor at no cost to the contract.
10. Segregation: Where only portions of a system are to be used, contractor shall specifically indicate how the used portion will be isolated from the unused portion. Plan shall address how to ensure that the reduced operation condition will be maintained within acceptable ranges, and/or how capacity will be throttled to keep all operating parameters in recommended ranges.

1.21 CONNECTION TO OR INTERRUPTION OF EXISTING SERVICES

A. Contractor shall exercise great care in the connection to or interruption of existing functional services (utilities, systems, spaces, etc.) that support the Owner's mission. This shall only be done with advance notification, completion of Owner documentation to obtain approval, and final approval and supervision by the Owner.

B. Refer to applicable Division 01 sections for logistics and requirements for connection to or interruption of existing services

C. All events where an existing service will be connected to or interrupted shall be itemized as a milestone or task in the construction Commissioning schedule. Owner will not approve the connection or interruption unless the event has been forecasted for at least three months. The schedule will not serve as the final notification but will support planning.

D. Final notification shall be per the Owner's process with all forms and submissions complete and accurate. Owner shall provide information on processes and applicable forms on request.

E. Depending on the service, Owner may dictate that the interruption be during non-working hours. In other cases, Owner will require the interruption be during working hours so mission can be monitored.

F. Contractor shall summarize the potential impact and the maximum duration

G. Owner reserves the right to cancel the connection or interruption at any time if it circumstances necessitate this. The Owner also reserves the right to constrain the extent of any interruption.

H. Connections to Hydronic Systems:

1. Connections to existing Hydronic systems shall be done only on mutual written approval of both parties to the connection. Owner and contractor shall review the fluid and piping condition and any applicable treatment and/or water analyses of the other parties system and agree to the connection.
2. Contractor shall work with the Owner to ensure the balance of the existing Hydronic system is not affected to the extent that it will affect mission. Therefore the contractor shall attempt to plan connections or interruptions for times when the impact will be the least.
3. Contractor shall record the balance of the existing system before and after the connection to document the impact. Balancing adjustments of the combined system shall commence immediately upon connection unless approved otherwise by the Owner.
4. Contractor shall work with the Owner to ensure any applicable pumps do not overload or become dead headed.

I. Connections to Air Systems:

1. Connections to existing Air systems shall be done only on mutual written approval of both parties to the connection. Owner and contractor shall review the air quality, inlets and ductwork condition and any applicable filtration of the other party's system and agree to the connection.
2. Contractor shall work with the Owner to ensure the balance of the existing Air system is not affected to the extent that it will affect mission. Therefore the contractor shall attempt to plan connections or interruptions for times when the impact will be the least.
3. Contractor shall record the balance of the existing system before and after the connection to document the impact. Balancing adjustments of the combined system shall commence immediately upon connection unless approved otherwise by the Owner.
4. Contractor shall work with the Owner to ensure any applicable pumps do not overload or become dead headed.

J. Connections to Electrical Systems:

1. Connections to existing Electrical systems shall be done only on mutual written approval of both parties to the connection. Owner and contractor shall review breaker/fuse settings, short circuit studies, load on system and condition of the electrical systems and equipment of the other party's system and agree to the connection.
2. Contractor shall work with the Owner to ensure the loading and coordination of settings is such that the connection will not affect mission. Therefore the contractor shall attempt to plan connections or interruptions for times when the impact will be the least. Contractor shall complete and document all interrupter settings and transfer switch timing per the short circuit study and design intent prior to the connection.
3. Contractor shall record the loads on the existing system before and after the connection to document the impact. Interrupter adjustments on the combined system shall commence immediately upon connection unless approved otherwise by the Owner.
4. Contractor shall work with the Owner to ensure any applicable distribution or generation equipment do not overload.

1.22 PHASING PLAN

A. If contractor intends to start, run, or occupy portions of systems in phases, contractor shall submit a plan for phasing in areas/portions of systems that will be connected subsequent to the initial portions. Specifically address:

1. Pipe and Duct Cleaning: indicate the configurations and protocols for isolating subsequent regions and then protecting the preceding regions when the subsequent region is cleaned/flushed and connected.
2. Pipe disinfection: Indicate the plan for disinfecting each region of potable water or medical gas pipe that requires disinfection. Indicate how the preceding regions of the system will be protected when connecting subsequent regions.
3. Piping Certification/Testing: Indicate the plan for certifying each region of pipe that requires certification and or testing such as laboratory gases, medical gases, and RO/DI water (testing for water quality). Indicate how the preceding regions of the system will be protected when connecting subsequent regions. Indicate how you will verify that the certification/test results on the previous systems have not been invalidated.
4. System Modifications: Indicate the protocols for making subsequent changes to the systems of pipe and duct when the systems have already been cleaned, flushed, pressure tested, disinfected, certified, etc..

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Standard Testing Instrumentation: Standard testing instrumentation normally used for performance assessment and diagnosis will be provided by the CA. Refer to Cx specifications for a list of applicable test equipment.

C. Special Tools: Special equipment, tools and instruments (only available from a vendor, specific to a piece of equipment) that are required for testing equipment in accordance with these Contract Documents shall included in the base bid price to the Contractor and turned over to the Owner upon completion of the project.

2.2 WEB-BASED COMMISSIONING PORTAL

A. General: The Commissioning Information Tool (ComIT) is a Microsoft Access-based software program integrated with a web based Portal. It allows multiple Parties to collaborate on commissioning information management using the Internet to interact with the Portal via a browser. ComIT uses a hierarchical object tree to represent building systems, components and devices. From this object tree you can access associated information at and below the applicable level. All applicable elements of information are associated with the object tree. ComIT facilitates either completing information directly via the software or by printing forms to fill out in the field.

B. Participation: All general and major subcontractors shall participate in the use of ComIT to document the Commissioning procedures. The use of the interface includes the electronic completion of all start-up procedures and the response/interaction with the Action List dialogue.

C. Requirements for Use: All contractors participating in ComIT must have the following based on their use:

1. Portal: This involves using the Portal via a browser. The Portal allows anyone with credentials to view the Commissioning information. Only individuals associated with the responsible Party can edit that information. This obviously requires establishing a connection to the internet.

2.3 COMIT TRAINING:

A. Included in the contract are two half-day training sessions given by Facility Dynamics (one scheduled near the Commissioning Kickoff Meeting and one scheduled prior to the first equipment start-up). Contractors shall send a representative to at least one training session. Each Contractor is entitled to two hours phone technical support beyond training sessions. Any addition phone support for non-bug related issues beyond this will be at cost.

2.4 TEST KITS FOR METERS AND GAGES

A. Test kits for meters and gages shall be provided to the Owner new and in good condition. Previously used test kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits required are specified in the individual technical specifications.

PART 3 - EXECUTION

3.1 START-UP STANDARD OF CARE

A. Procedures that establish a minimum Standard-of-Care for the start-up, check out and testing of applicable equipment are specified in the individual technical specifications as well as the Cx specifications. Contractor shall apply this Standard-of-Care and document per the Commissioning requirements.

3.2 FUNCTIONAL PERFORMANCE TEST EXECUTION

A. Functional Performance Testing procedures are specified in Section 019114. Contractor shall participate in the development and approval of the testing procedures, as well as participate as required in the initial sample of tests as indicated herein.

3.3 ACTION LIST

A. CA shall maintain an Action List tracking Action Items (required information, identified deficiencies, work required, etc.) that relate to Commissioning. Each item shall be tracked with the initiator, the parties responsible, due date, the date of closure, and a description of the resolution. Each item shall be categorized for sorting and tracking and for documentation on applicable forms.

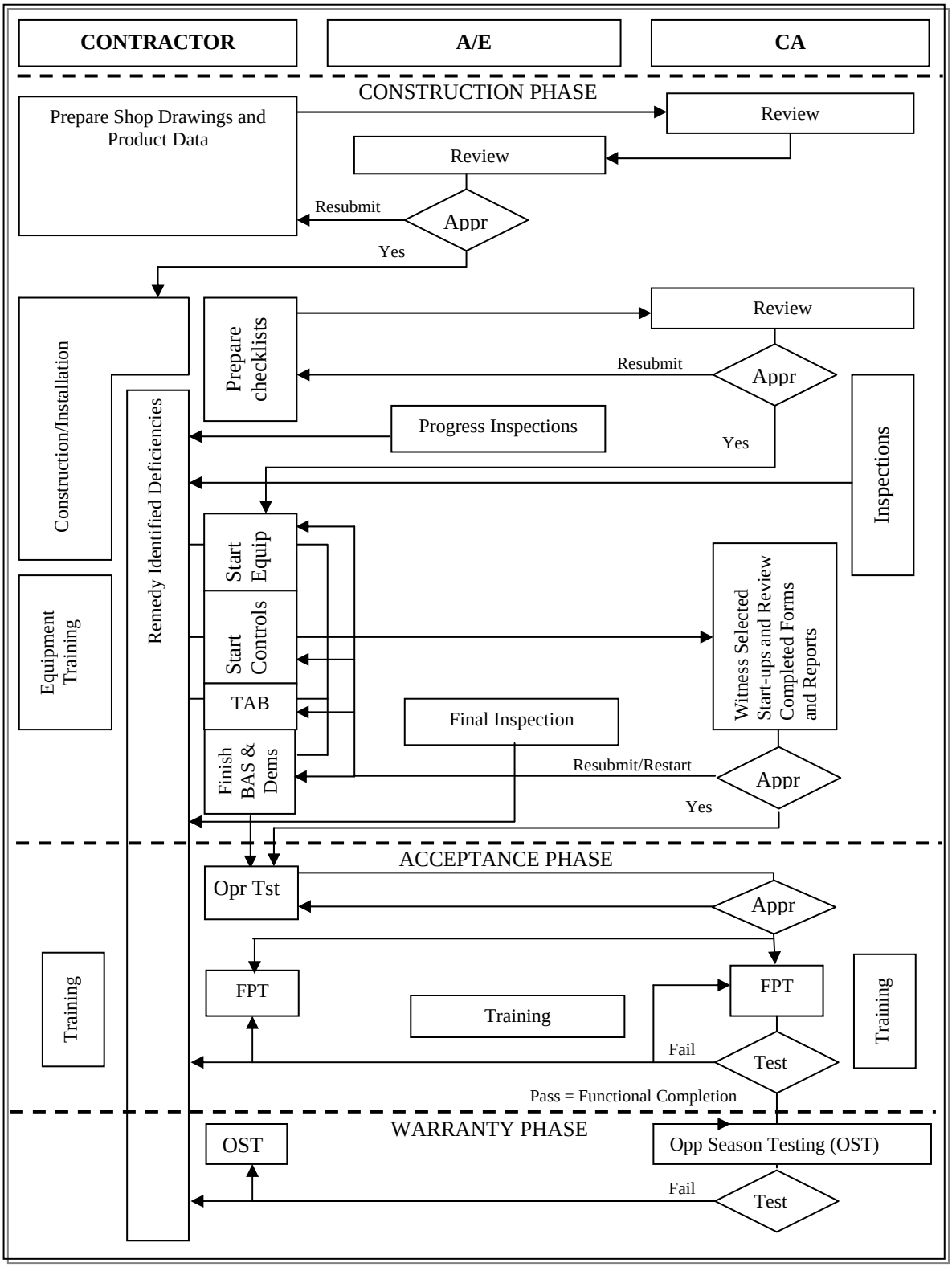
B. CA will disseminate this list as appropriate to keep all parties informed.

C. All parties indicated as responsible for an action item shall respond. Parties shall respond via the Web Portal interface to ensure all of the dialogue is documented in the testing database.

D. The originator of an Action Item shall close it and record the resolution. Closing an Action Item amounts to entering the date on which it was addressed.

3.4 SEQUENCING ILLUSTRATION

A. A simplified schematic diagram of the precedents involved in the Commissioning process is provided below. The diagram is generally applicable on a system-by-system basis. Different systems or areas of the building may be phased or sequenced such that different systems are at different points in the Commissioning process. The diagram indicates tasks for the Contractor, the A/E and the CA. Tasks for each are indicated vertically below their name. The individual tasks are as defined herein. Management protocols are also covered herein.



Sequencing Illustration

END OF SECTION 019113

SECTION 019114 – FUNCTIONAL PERFORMANCE TESTING PROCEDURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Functional Performance Testing of systems.

B. Documentation of FPTs

C. Acceptance criteria

D. Interactive System Functional Performance Testing (FPT) of systems.

1.2 SCOPE

A. This section describes the Functional Performance Testing (FPT) process, procedures, and requirements. It is intended to illustrate (i) the Contractor's requirements for assisting the Commissioning Authority (CA) with the functional performance testing of systems, and (ii) to demonstrate the level at which systems and equipment will be tested prior to being deemed 'Acceptable' to the Owner.

B. The CA will prepare itemized and detailed testing plans and procedures that:

1. Specify individual tests and procedures that meet the general requirements of the Cx Plan and commissioning process;
2. Serve to document and record the testing procedures and the results of the tests.

C. The Contractor shall provide technical input to the CA as needed during the development of the final project FPTs.

D. Example (referred herein to as 'generic') FPTs are provided as illustration to the Contractor of the level of detail to which FPTs will be conducted.

1.3 RELATED WORK AND DOCUMENTS

A. Commissioning Plan: The Cx Plan is part of the Contract Documents and outlines many of responsibilities, procedures and tasks throughout the Cx process. It encompasses the entire Cx process including phases prior to construction and roles of all Parties. It also describes the Functional Performance Tests that will be performed during the Acceptance Phase.

B. Section 019113 – General Commissioning Requirements: details the Cx requirements common across all divisions

C. Section 019114 – Functional Performance Testing Procedures: Outlines the generic functional testing procedures required.

D. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

E. Section 110800 – Specialty Equipment Commissioning: Details the commissioning procedures specific to Specialty Equipment (Div 11) work.

F. Section 140800 – Conveying Equipment Commissioning: Details the commissioning procedures specific to Elevator (Div 14) work.

G. Section 210800 – Fire Suppression Systems Commissioning: Details the commissioning procedures specific to Fire Suppression Systems (Div 21) work.

H. Section 220800 –Plumbing Systems Commissioning: Details the commissioning procedures specific to Plumbing Systems (Div 22) work.

I. Section 230800 – HVAC Systems Commissioning: Details the commissioning procedures specific to HVAC (Div 23) work.

J. Section 230995 – Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.

K. Section 260800 – Electrical Systems Commissioning: Details the commissioning procedures specific to Electrical (Div 26) work.

L. Section 270800 – Telecommunication Systems Commissioning: Details the commissioning procedures specific to Telecommunication (Div 27) work.

M. Section 280810 – Security Systems Commissioning: Details the commissioning procedures specific to Security Systems work.

N. Section 280820 – Fire Alarm Systems Commissioning: Details the commissioning procedures specific to the Fire Alarm System work.

O. Section 330800 – Utility Systems Commissioning: Details the commissioning procedures specific to the underground utilities work.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113.

1.5 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope: Systems shall be tested to ensure proper operation through all modes of operation including normal expected operation, maintenance operation as well as proper response to system and component failures that are considered abnormal operation as indicated below.

1. Normal Operation: In general, each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. These series of tests will demonstrate that the systems and equipment operate throughout typical operation including normal adjusting, cleaning, media replacement, and maintenance.
2. Abnormal Operation: Test each system to simulate possible abnormal conditions and verify proper responses to such modes and conditions as power failure, equipment and component failure, freeze condition, deviation of operating parameters outside of normal, no flow, supporting utility failure,

human error, etc.. This series shall demonstrate proper and safe response to the focus systems and the other systems that it affects or integrates with. These tests shall also demonstrate proper enunciation of abnormal conditions to quickly and effectively notify users and operators of such condition. Specific modes required in this project are given in this section and any other sections where test requirements are found.

B. Development of Test Procedures: CA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection, and scope. The CA will also submit the tests to the A/E for review.

1. Contractor shall review the FPTs in detail.
2. The CA shall review Owner-contracted testing, factory testing, or required Owner acceptance tests for which the CA is not responsible to oversee. Review shall include content, scope, and documentation format, and shall determine what further testing or format changes may be required. Redundancy of testing shall be minimized.
3. The purpose of any given specific FPT is to verify and document compliance with the stated criteria of acceptance.

C. Scheduling: After Contractors notification that systems are ready for testing and submittal and review of all the required submittals has occurred, CM shall schedule the testing. To the extent practical, tests shall be scheduled to allow efficient and contiguous testing of inter-related systems and equipment.

D. Phasing: Non-interdependent segments of the project testing can be phased. Actual phasing of this project will determine the systems which can be phase-tested. CA will coordinate the scheduling with the CM and project Team.

E. Participation: CA will direct and conduct functional performance tests after Start-Up Procedure documentation of systems and equipment has been reviewed and accepted. Conceptual procedures for the functional performance testing are outlined elsewhere in this Section. CA will execute the FPTs unless otherwise specified. Contractor shall assist with manipulation of the systems or equipment, provision of supporting equipment or materials (lifts, ladders, specialty test equipment, safety equipment), and on-the-spot remediation of minor identified deficiencies whenever possible. Contractor support shall be at the direction of the CA as follows.

1. The Contractors have been allotted “FPT Support Hours” in Part III of this Specification Section. This time includes only that for demonstration of the systems, at the direction of the CA, outside of any other testing. Testing witnessed by the CA in the presence of other various Contractors or vendors does not constitute time accrued against these hours. Similarly, start-ups, repairs, warranty, training, vendor training, any directly referenced task hours in the specifications, etc. are outside of these hours.
2. Time required by the Contractors to re-test failed systems, components, or integrated tests which did not meet specification in the initial testing; responding to action items; or repairing/resolving deficiencies do not count against the FPT Support Hours allotment.
3. The CA will request the Contractor support in a minimum of 4-hour increments. The Contractors must supply a qualified technician or trade contractor, skilled in the respective area of systems testing, to work with the CA. The hours used for FPT support will be tracked by the CM similar to T&M hours, and each increment of work by each technician will be approved by the CA. If the technician/trade contractor is unable to demonstrate the systems, no time for that person will be counted for the FPT segment.
4. No Party involved with the project is prohibited from participation in or witnessing of any tests. Any Contractor may elect to witness all tests on their systems even if their involvement is not directly requested by the CA. In this instance, none of the time for that person will be counted as FPT support from the pool of hours.

5. The FPT Support Hours are an estimate of the hours needed by each trade contractor and should be included in their base bid.
6. CA will endeavor to coordinate effectively with the individual Contractors throughout FPT and minimize their required involvement.
7. Contractor assumes responsibility for damage to systems conducted in accordance with the approved procedures.

F. Detailed Test Procedures and Contractor Review: CA will prepare detailed and itemized testing procedures to define and document the FPT. These will be developed during the Construction Phase and completed during the Acceptance Phase. The CA shall submit these procedures to the Contractor for review. Contractor shall indicate all required limitations, safety procedures, maximum thresholds, and any other parameters during the FPT development. Contract shall be responsible for any damage to the equipment caused by functional performance testing done per the procedures and within the limitations of the approved procedures.

G. Completeness: All systems must be completed and ready for FPT. All start up, factory authorized field testing, independent testing agency tests, and TAB procedures must be complete and the control systems must be tested and started for the respective system or component.

H. Test Documentation: CA will conduct tests, and/or witness tests as applicable. CA will record all test results on the forms developed for the testing. CA will 'Pass' or 'Fail' the testing and record the date and time of the test. Deficiencies shall clearly be indicated when the test is failed. When all related testing is completed successfully, CA shall recommend acceptance of the system or component.

I. Deficiencies and Re-Testing: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. More significant deficiencies will require failure of the test and re-testing. Deficiencies of this magnitude will result in an Action Item on the Action List. The resolution of the deficiency will then subsequently be tracked by the CA via the Action List. All tests shall be repeated until successful completion. Refer to more specific provisions below.

J. Sampling: Some types of identical equipment (such as terminal devices) will be tested using a sampling strategy. The sample percentage is indicated in the generic FPT provided elsewhere in this Section.

K. Max Failure Limit and Sample Percentages: A Maximum Failure Limit is indicated along with the Sampling Percentages. The Max Failure Limit indicates the maximum percentage of the tested devices that may have any test that fails before an entirely new sample must be tested. This is based on the concept that if many failures occur, it is a result of inadequate start-up by the Contractor. When the maximum number of failures is reached, testing on that sample will be terminated and re-testing will be scheduled.

1. If no Max Failure Limit is indicated, all tested samples must pass (Max Failure Limit 0%).
2. Where sample tests involve multiple systems (i.e., checking strainers on different hydronic systems) the Maximum Failure Limit will apply per system.
3. The responsible Contractors shall pay the CA cost of that sample test, and redo the start-up/TAB for the applicable devices/systems.
4. All work necessitated by sample failures shall be at no cost to the Owner.

L. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. Opposite Season testing will be required where scheduling prohibits thorough testing in all modes of operation. Air handler and central heating system testing for heating-related modes of operation and control loops shall be tested during outside air temperatures below 35°F.

M. Approval: The CA passes each test and subsequently recommends approval to Owner or CM who reviews and approves the FPT.

1.6 COORDINATION BETWEEN TESTING PARTIES

A. Factory Start-Ups: For many systems and equipment, Factory Start-Ups are specified. These Factory Start-Ups will be reviewed and checked during functional performance testing. All costs associated with the Factory Start-Ups are included with the bid unless otherwise noted. In general, Contractor shall make notification of when Factory Start-Ups are occurring and coordinate these with witnessing Parties. The CA and CxT members may witness Factory Start-Ups at their discretion. Aspects of functional performance testing accomplished during the Factory Start-Ups may be accomplished and approved by the CA if they meet the intent of the FPT.

B. Independent Testing Agencies: For systems where Independent Testing Agencies are specified, the cost of this testing is included with the bid unless otherwise noted. Much of the testing performed by these independent agencies will cover aspects required in the Start-Up Procedures and functional performance tests.

1. Contractor and testing agencies shall coordinate with the CA so that the CA can witness the testing and approve the applicable aspects of the FPTs.
2. The CA may in some cases independently spot-check work of the testing agencies if the tests were not witnessed. However, it is not the intent for the CA to re-accomplish testing by others that is specified in the construction specifications. For instance, much of the testing requirements for the electrical systems will be performed by the independent electrical testing agency provided under the bid. The CA shall witness the indicated sample of the testing and record the results in the record of functional performance tests.
3. Contractor is responsible for coordinating the efforts of testing agency with that of the Cx process. Documentation shall be contiguous and seamless and duplication should be avoided. Testing agencies shall complete the documentation of the Cx process as required.

C. Specialized Testing by Contractor: Where specialized testing is specified in the technical specifications, Contractor, subcontractor, vendor, or factory representative as applicable shall conduct the specified testing and provide all specialized instrumentation and equipment. CA and other CxT members may witness tests at their discretion. The CA may in some cases independently spot-check the results of the tests if the tests were not witnessed. However, it is not the intent for the CA to re-accomplish testing that is specified in the construction specifications. All specialized testing procedures shall be integrated with the Cx process and all documentation shall be coordinated and integrated with the documentation of the Cx process. Examples of specialized testing include:

1. Generator load testing (not building power outage functional testing which will be administered by CA)
2. Acceptance testing of the Fire Alarm System
3. Water purity tests on a RO/DI system
4. Laboratory Gas Cross Connection testing
5. Uninterruptible Power Supply
6. Medical Air and Gas Certification
7. Fume Hood Acceptance Testing
8. Electrical System Testing per NETA
9. Room Leakage Testing
10. Chemical Shower System

1.7 FPT ACCEPTANCE CRITERIA

A. The Acceptance Criteria shall be as follows unless more specifically indicated within individual tests. CA may exercise professional judgment to relax requirements and pass tests and recommend approval when appropriate.

1. Capacity and/or equipment performance will generally be as specified ±5%.
2. Efficiency where specifically indicated in the documents will be ±5%. When inferred from manufacturer's catalogue data, criteria will be ±10%.
3. Balancing-related criteria will be ±5% for water and ±10% for air.
4. Accuracy/repeatability on sensing devices will be as specified for the device. CA and TAB will use calibrated gages for independent validation and use judgment in passing or failing the devices. In many cases, the coordination of multiple related sensors is more important than absolute accuracy.
5. Loop response and setpoint deviation criteria will be as specified in BAS Cx specification.
6. HVAC sequence-related criteria will be as explicitly specified in the documents and as interpreted by the CA. Code required sequencing shall be per the applicable code.
7. System sequences shall be as required by the approved shop drawings.
8. Motor Phase Imbalance: Shall be no more than 2% (Amps and Volts).
9. Noise Levels:

    a. Occupied spaces: As indicated in the Basis of Design document. Otherwise, noise level shall be as recommended in the most current version of the ASHRAE Handbooks for the applicable occupancy.
    b. Max 77dBa at 3' from a UPS.
    c. Max 65dBa at 7' from an Engine Generator Set.
    d. At limits of the enterprise or facility: As required by current local ordinances.

10. Indoor Environmental Parameters (T, RH): Shall be as indicated in the Basis of Design document. Otherwise, as recommended in the most current version of the ASHRAE Handbooks for the applicable occupancy.

    a. General Occupied Rooms: Setpoints from 70-75°F +- 3°F and 45% RH +- 15% RH
    b. Data Center Computer Rooms: Setpoints from 69-73°F +- 2°F and 50% RH +- 5% RH
    c. Laboratories Rooms: Setpoints from 70-75°F +- 2°F and 45% RH +- 10% RH

11. Air Pressurization: As indicated in the Basis of Design document; otherwise, as indicated in the most current version of the ASHRAE Handbooks for the applicable occupancy. Smoke/shaft pressurization shall be as required by NFPA to maintain maximum door opening forces and to restrict the passage of smoke.
12. Indoor Lighting Levels: As indicated in the Basis of Design document. Otherwise, as recommended in the most current version of the IES Handbooks for the applicable occupancy.
13. Electrical Systems: Shall be in accordance with manufacturer's recommendations of individual components and devices, NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-Latest Version.
14. Inter-system interfaces and coordination: as specified and generally to ensure safe, reliable, and robust operation.
15. Biosafety Cabinets: With fans off and sash at normal position:

    a. Average Face Velocity 100 fpm +- 10 cfm
    b. Max Face Velocity Deviation: 15%

16. Fume Hood Response: As defined in the modified ASHRAE procedure. This includes:

a. Face Velocity: 100 fpm±5%
b. Time to Steady State upon a sash movement (no excursion beyond ±10% of steady state) : <2 sec
c. Rate of Response to a sash movement: <0.5 sec.
d. Overshoot (peak max and min deviation from steady state in percent of steady state) : <15%

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available. Supplier of instrumentation shall submit the calibration certificates along with the start up documentation.

B. Standard Testing Instrumentation: Standard instrumentation normally used for performance assessment and diagnosis will be provided by the CA for tests being conducted by CA. All other instrumentation shall be provided by the Contractor. The instrumentation to be provided by the CA includes:

1. Electronic Manometer (for Air and Flow Hood)
2. Electronic Manometer (for Water)
3. Temperature Instruments and Gages
4. Humidity Instrument and Gage
5. CO2 Instrument
6. Sound Meter
7. Light Level Meter
8. Electronic Multimeter
9. Power Analyzer (including power factor and THD)
10. Receptacle Tester
11. Tachometer
12. Belt Tensioner
13. Ultrasonic Flow Meter
14. Vibration meter capable of measuring acceleration peak to peak

C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and provided to the Owner.

PART 3 - FUNCTIONAL PERFORMANCE TESTS (SYSTEMS AND EQUIPMENT RELATED)

3.1 PREREQUISITES

A. All equipment, components, and devices applicable to the FPT must be started and the Start-Up must be documented and passed. This includes completion of Start-Up Procedures, pressure testing of equipment, duct, piping; flushing/cleaning of applicable systems; completed labeling and identification; completed insulation of applicable systems; and all other requirements for placing system into dynamic operation. The completed, successful, start-up of the systems must be evidenced by the associated checks, tests, and vendor forms filled out and uploaded to the Cx Portal.

B. Unless specifically agreed to by the Owner and CA, all support systems shall be complete prior to FPT. For instance, an air handler will require that:

1. The electrical system serving it is completed and tested;
2. The hydronic systems serving it have been pressure tested, flushed, and functional performance tested;
3. Balancing has been accomplished on the air and water sides;
4. The control systems have been started and calibrated.

C. The CA shall determine the optimal sequence of testing.

3.2 FUNCTIONAL TESTING PROCESS

A. Functional Testing on any given system shall generally begin with testing device level elements; progress to component level; to system level, to inter-system level to building level.

B. Functional Testing of systems shall generally proceed from the utilities to the central systems, to the distribution systems, to the zone terminal units and services. CA shall plan this process and communicate it through a precedent diagram (in Gantt and Pert or Excel format). Construction Manager shall reflect that process in the Construction Schedule. Subcontractors shall perform work in accordance with the schedule.

3.3 COMMON ELEMENTS FOR ALL SYSTEMS

A. Required submittal documentation shall be present and located convenient to testing area. Validate that all required documentation has been submitted and is per the contract requirements.

B. Contractor shall provide the completed Start-Up Procedures at the time of testing. CA shall review the Start-Up Procedure documentation and spot-check at the beginning of FPT.

C. Contractor shall demonstrate that access is sufficient to perform required maintenance.

D. BAS trends shall have been established as required in the documents. These shall generally be reviewed prior to or during FPT.

E. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing. Those on emergency power or uninterruptible power shall be tested on all sources.

F. Capacities and adjusted/balanced conditions as applicable shall be subject to check.

G. Sequencing Verification: All modes of operation and actions shall be verified for equipment/system samples

H. System and equipment configurations shall be compared against the contract documents.

I. Verify functions (such as heating and cooling) are coordinated and do not overlap or ‘fight’.

J. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation.

K. BAS or Local Panel Dynamic Graphics: The graphic displays for all components, systems, and areas required to be represented by a graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints or other parameters are required to be adjustable, CA shall verify that they can be adjusted directly from the graphic screen.

L. Emergency power tests for mechanical systems will be conducted in concert with the testing of the emergency power systems. Mechanical contractor shall be available for the power outage test to test mechanical systems under a power outage. This is in addition to the requirements specified for the mechanical system.

M. Where system and zones are designed for various modes of operations and are indicated as such in the Systems Guide, test representative systems in all modes of operation. This includes:

1. Seasonal Modes
2. Sequencing Modes
3. Emergency Modes
4. Potential configurations of containment zones

3.4 CONTRACTOR PARTICIPATION HOURS

A. The Trade Contractors shall include an allowance for FPT support of the demonstration of the systems, at the request of the CA. The FPT Support Hours to be included, as part of the base bid by Trade, are as follows:

1.	Construction Manager FPT Support -	8 hours
2.	Fire Protection (FPC) FPT Support –	8 hours
3.	Mechanical (MC: HVAC and Plumbing) FPT Support –	32 hours
4.	Building Automation System (ATC) FPT Support –	48 hours
5.	Electrical (EC) FPT Support –	48 hours
6.	Telecom (Tele) FPT Support –	16 hours
7.	Security (Sec) FPT Support –	24 hours
8.	Fire Alarm (FAC) FPT Support –	16 hours
9.	Testing and Balance (TAB) FPT Support –	40 hours
10.	Vendors FPT Support –	(As req'd)

PART 4 - INTERACTIVE SYSTEM FUNCTIONAL PERFORMANCE TESTS

4.1 PREREQUISITES

A. Functional Performance Testing for all individual systems, equipment, components, and devices applicable to the Interactive System Functional Performance Tests (ISFPT) must be have successfully passed system level functional testing and all FPTs must be documented.

B. Minor punchlist items may be outstanding provided they do not affect functionality and provided that all punch list items or incomplete work have been documented by the Contractor at the time they notify the CxT that they are ready for ISFPT. If a punch item causes the failure of any aspect of the ISFPT, that contractor will be responsible for the cost of retesting.

C. Generally all component, equipment, and systems training shall be completed. Exceptions to this include BAS Final Sequence Training, Commissioned System Training, and occupant training on use of specialized equipment, and as otherwise approved by Owner and CA.

D. The CA shall work with the CM determine the optimal sequence of testing. ISFPTs shall be itemized and specifically indicated in the construction schedule.

E. Owner-furnished FF&E may be used in ISFPTs in some cases. Coordinate with the Owner to obtain and connect this equipment. Examples include:

1. Fume Hoods
2. Spot Hoods and Snorkel Exhausts
3. Bio-indicators for decontamination tests

4.2 ISFPT PROCESS

A. ISFPT will generally be done at the inter-system level to building level.

B. ISFPT will generally require extensive coordination to avoid simulating various interactions and affects multiple times for each system. Generally the ISFPT will begin with a meeting to coordinate responsibilities and sequence.

C. CA shall work with the CM to plan the overall ISFPT progression and communicate it through a precedent diagram (in Gantt and Pert format). CM shall reflect that process in the Construction Schedule. Subcontractors shall perform work in accordance with the schedule.

D. ISFPTs will affect, or be an element of, most system functional tests. Results of these tests will be recorded in the context of the individual system tests although the testing will generally be done on many of the systems at the same time. CA shall record the overall results of the ISFPT; however the details will be recorded in the context of the applicable systems, equipment, or zones.

E. Communications are critical during ISFPTs. CM shall provide radios with sufficient range to cover the building and or place personnel to relay communications when necessary.

F. Participation: Unless noted otherwise, ISFPTs will require participation of all indicated parties for the entire test. ISFPTs will not be done on a sampling basis. While sampling of individual systems might be part of the ISFPT, the ISFPT itself will not be considered a sample.

G. Remediation of Deficiencies: Minor deficiencies may be remedied during the FPT only with the consent of the CA who will poll all parties involved. Given the extent of coordination required with the ISFPT, reasonable efforts will be made to fully complete and pass the test on the scheduled date.

H. Failures: The parties responsible for failures of ISFPTs will be responsible for the cost of any necessary retesting as provided for under Section 019113.

I. Monitoring and Trending: For almost all of the ISFPTs, monitoring of various systems must be in place and trends shall be set up to archive conditions throughout the test. In many cases, analysis of the trends will be the basis of assessing success. As the ISFPTs will be performed towards the end of the Acceptance Phase, contractor shall ensure all trending shall be in place as required by the applicable system functional performance tests throughout the entire Acceptance Phase.

4.3 INTEGRATED SYSTEMS FOR TESTING

A. Emergency Generator Test

B. Fire Alarm/ HVAC Integration Test

END OF SECTION 019114

SECTION 020100 – SUBSURFACE EXPLORATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

1.2 DESCRIPTION OF CONTENTS:

A. Existing Subsurface Conditions: A subsurface investigation has been conducted at the project site to determine general subsurface conditions. A copy of the report is included in this section.

1.3 RELATED WORK:

A. Division 31 Sections "Site Clearing" and “Earth Moving” for earthwork requirements.

1.4 RESPONSIBILITY OF DATA:

A. The Owner and Architect are not responsible for interpretations or assumptions made by the Contractor based on the subsurface exploration data furnished. The data is made available for the Contractor’s convenience. Opinions expressed in the report are the interpretation of the geotechnical engineer based on analysis and tests conducted by his firm. Additional subsurface investigations may be made by the Contractor at no increase to the contract sum. Obtain written authorization from the Owner before proceeding with subsurface investigations.

B. Subsurface Materials: Boring logs indicate the general character of subsurface materials encountered only at boring locations.

C. Groundwater: Groundwater levels for the project site are not known. Groundwater fluctuations may occur with variations in precipitation, surface run-off and existing utility leakage.

PART 2 - PRODUCTS: (Not Used)

PART 3 - EXECUTION: (Not Used)

REPORT OF

SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING ANALYSIS

MONTGOMERY COLLEGE BIOSCIENCE CENTER
OBSERVATION DRIVE
GERMANTOWN, MARYLAND

FOR

THE LUKMIRE PARTNERSHIP

JULY 8, 2008

ECS MID-ATLANTIC, LLC
Geotechnical • Construction Materials • Environmental • Facilities

July 8, 2008

Mr. Greg Lukmire
The Lukmire Partnership
2700 South Quincy Street
Suite 300
Arlington, Virginia 22206

ECS Job No.: 13-3361

Reference: Report of Subsurface Exploration and Geotechnical Engineering Analysis, Montgomery College Bioscience Center, Observation Drive, Germantown, Maryland

Dear Mr. Lukmire:

As authorized by acceptance of our proposal dated March 27, 2008, ECS Mid-Atlantic, LLC (ECS) has completed the subsurface exploration and geotechnical engineering analysis for the Montgomery College Bioscience Center. The site is located at the Montgomery College-Germantown Campus on Observation Drive in Germantown, Maryland. Our report, including the results of our subsurface exploration program, laboratory analysis, and geotechnical engineering analysis is enclosed with this letter, along with a Site Location Diagram and a Boring Location Diagram.

The construction will consist of a multi-story building housing the Bioscience Education Center. We understand that the building will be two above-grade levels and will also include a partial basement. The proposed entry level elevation is EL 573.5. Maximum column loads will be on the order of 400 to 600 kips and maximum wall loads will be on the order of 5 kips/foot.

The enclosed report provides comments on soil bearing pressures, foundation settlement estimates, placement and compaction of new fills, drainage, construction, and other factors which may influence construction at the site.

We appreciate this opportunity to be of service to The Lukmire Partnership on this project. If you have any questions regarding the information and recommendations contained in the accompanying report, or if we may be of further assistance to you in any way during planning or construction of this project, please do not hesitate to contact us.

Respectfully,
ECS MID-ATLANTIC, LLC

Gregory A. Ratkowski
Project Engineer

Jeffrey A. McGregor, P.E.
Geotechnical Manager

STATE OF MARYLAND
JEFFREY A. McGREGOR
No. 30901
PROFESSIONAL ENGINEER

Enclosures: (1) Report
I:\Department 3 Geotechnical\GEOTECHNICAL\Projects\3300's\3361\13-3361 Montgomery College Bioscience Center.doc

REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING ANALYSIS

PROJECT

Montgomery College Bioscience Center
Observation Drive
Germantown, Maryland

CLIENT

Mr. Greg Lukmire
The Lukmire Partnership
2700 South Quincy Street
Suite 300
Arlington, Virginia 22206

Submitted by
ECS Mid-Atlantic, LLC
5112 Pegasus Court
Suite S
Frederick, Maryland 21704

PROJECT 13-3361

DATE July 8, 2008

MONTGOMERY COLLEGE BIOSCIENCE CENTER

TABLE OF CONTENTS

PROJECT OVERVIEW

Project Location and Proposed Construction

The Bioscience Center will be part of the Montgomery College-Germantown Campus. The project site is at the end of Observation Drive in Germantown, Maryland. A Site Location Diagram, included in the Appendix of this report, shows the approximate location of this project.

The proposed construction will consist of a multi-story building housing the Bioscience Education Center. The project site is currently occupied by an asphalt parking lot and woods. The site sits to the south of the existing Sciences and Applied Studies building. We understand that the building will be two levels and will also include a partial basement. Structural loading information was provided by the structural engineer, ReStl Designers. The building will have maximum column loads of approximately 600 kips and wall loads on the order of 5 kips per foot. The proposed entry level finished floor elevation is EL 573.5. The proposed lower level elevation is EL 559.5. Based on existing site grades as shown on the provided plan, fills of approximately 1 to 8 feet and cuts on the order of 5 to 16 feet are expected to be necessary to reach proposed finished floor grades. We also understand that total and differential settlements must be limited to ½ and ¼ inches, respectively.

Scope of Work

The conclusions and recommendations contained in this report are based on our field subsurface explorations, laboratory testing, and review of available geologic and/or geotechnical data. The subsurface exploration program included a total of 15 soil borings, extended to a maximum depth of 40 feet below the existing ground surface and one pavement core to evaluate existing conditions along Observation Drive. Visual classifications and laboratory testing were then performed on soil samples to classify the soils and to assist in determination of the properties of the on-site soils. We also visited the site to conduct a site reconnaissance of current conditions.

The boring locations were selected and located in the field by personnel from A. Morton Thomas. The Boring Location Diagram in the Appendix indicates the approximate physical location of the borings performed at the site.

Purposes of Exploration

The purpose of our subsurface exploration was to explore current soil and groundwater conditions at the site and to develop engineering recommendations to guide in the design and construction of the proposed project. We accomplished these purposes by:

1. drilling borings to explore the subsurface soil and groundwater conditions,

2. installing temporary standpipes to monitor long-term water levels,

3. performing one pavement core to evaluate existing pavement conditions,

4. performing visual classification on the soil samples from the borings to evaluate pertinent engineering properties, and

5. analyzing the field and classification test results to develop appropriate engineering recommendations.

EXPLORATION PROCEDURES

The soil borings were performed using an all-terrain mounted auger drilling rig, (CME 550), which utilized continuous flight, hollow stem augers to advance the boreholes. Drilling fluid was not used in this process.

Representative soil samples were obtained by means of the split-spoon sampling procedure in accordance with ASTM Specification D-1586. In this procedure, a 2-inch O.D., split-spoon sampler is driven into the soil a distance of 18 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through the last 12-inch interval is termed the Standard Penetration Test (SPT) value, or N value, and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of noncohesive soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

A field log of the soils encountered in the borings was maintained by the drill crew. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample were then sealed and brought to our laboratory for further visual examination.

Each soil sample was classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. A brief explanation of the Unified System is included with this report. The various soil types were grouped into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs and profiles are approximate; in situ the transitions may be gradual.

Laboratory Testing Program

Representative soil samples were selected and tested in our laboratory to check the field classification and to determine pertinent engineering properties. The laboratory testing program included visual sample classifications, moisture content tests, Atterberg Limits, washed sieve gradation tests, and moisture-density relationships (proctor). All data obtained from the laboratory tests are included on the respective boring logs on separate sheets in the Appendix.

Each soil sample was classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. A brief explanation of the Unified System is included with this report. The various soil types were grouped into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs and profiles are approximate; in situ the transitions may be gradual.

EXPLORATION RESULTS

Current Site Conditions

The proposed building site is slightly sloped and partially occupied by an asphalt parking lot and woods. The site generally slopes downward from west to east with elevations ranging from approximately EL 575 to EL 525. Access to the site was obtained off of Observation Drive.

Regional Geology

The project site is located in the Piedmont Physiographic Province, an area underlain by ancient igneous and metamorphic rock. The virgin soils encountered in this area are the residual product of in-place chemical weathering of the parent rock presently underlying the site. The typical residual soil profile consists of silty to clayey soils near the surface where solid weathering is more advanced, underlain by more sandy silts and silty sands that generally become harder and denser with depth to the top of parent bedrock. The boundary between soil and rock, termed weathered or decomposed rock, is not sharply defined. This transitional zone can contain boulders of more resistant rock as well as highly weathered materials. Materials labeled as "Decomposed Rock" on the boring logs exhibit the remnant structure of the underlying parent bedrock. Variable weathering is not uncommon in this area and should be expected.

According to the Geologic Map of Maryland (1968), the project site appears to be underlain by western piedmont metasedimentary rock of the Marburg Schist Formation. The Marburg Schist Formation is characterized as bluish-gray to silver-green, fine-grained, muscovite-chlorite-albite-quartz-schist, intensely cleaved and closely folded, and contains interbedded quartzite.

Soil Conditions

Subsurface conditions within the project site were evaluated with 15 soil test borings drilled to maximum depth of 40.0 feet below the existing ground surface. The approximate boring locations are presented on the enclosed Boring Location Diagram.

Approximately 2 to 4 inches of topsoil was encountered at the ground surface at boring locations B-2, B-4, B-6 through B-12, and P-3. Approximately 2 to 6 inches of gravel was encountered at the ground surface at boring locations B-1, B-3, and B-5. Approximately 3 to 4 inches of asphalt underlain by 4 inches of crushed stone base was encountered at the ground surface at boring

locations P-1 and P-2. About 2.5 to 5 feet of existing fill material was encountered below the surface cover at all boring locations except borings P-2 and P-3. The existing fill material consisted of Sandy SILT (ML-FILL) with varying amounts of clay, gravel, rock fragments, and root matter. The density of the fill material was generally loose to medium dense.

Natural soils were encountered below the fill layer, and consist primarily of Sandy SILT (ML) with varying amounts of decomposed rock and rock fragments. The density of the natural soil was generally firm to dense. Loose natural soils were encountered in some of the borings. The color of the natural soils was generally brown and brownish gray to reddish brown and the moisture contents of these materials were generally characterized as moist.

Below the natural soils very dense material with a blow count greater than 60 has been noted on the boring logs as decomposed rock. Decomposed rock materials were encountered in all borings except borings B-6, B-7, B-11, B-12, P-1, and P-3 between depths of about 3.5 feet to 33.5 feet below existing grades. These materials exhibit rock like qualities and depending on various parameters may be extremely difficult to excavate, and may require rock excavation methods for removal.

Auger refusal was encountered in borings B-1, B-2, B-3, B-6, B-9, and B-10 at depths ranging from 9.0 feet to 36.5 feet below the existing ground surface. Auger refusal depth is assumed to be the bedrock surface in the borings. More detailed descriptions of the soils encountered are presented on the Boring Logs in the Appendix.

Groundwater Observations

In auger drilling operations, water is not introduced into the boreholes, and the groundwater position can often be determined by observing water flowing into or out of the boreholes. Furthermore, visual observation of the soil samples retrieved during the auger drilling exploration can often be used in evaluating the groundwater conditions. Observations for groundwater were made during sampling and upon completion of the drilling operations at each boring location. Water was not encountered in the borings during drilling or upon completion. Twenty-four hour water level readings taken from temporary standpipes installed in borings B-10, B-20, and B-25 indicate that the borings were dry. Cave in depths ranged from 6.5 feet to 22.5 feet.

The highest groundwater observations are normally encountered in winter and early spring. Variations in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, and other factors not immediately apparent at the time of exploration. Free water may also be encountered at the interface of fill soils and natural soils, or at the interface of natural soils and decomposed rock or bedrock.

Flooding

Based on "FEMA Flood Insurance Route Map 24031C0180D", Montgomery County, Maryland, the project site is classified as zone X. Zone X is defined as areas of 0.2% annual chance flood with average depths of less than one foot or with drainage areas less than one square mile. The project site was determined to be outside the 0.2% annual chance floodplain.

ANALYSIS AND ENGINEERING RECOMMENDATIONS

The recommendations presented in this report are based on the project information provided to us, the results of the soil test borings, and our engineering analysis. Considering the results of our field exploration, and based on our experience with similar projects, we believe that the proposed building may be supported on multiple shallow foundation systems consisting of traditional spread footings and spread footings supported on geopiers or stone columns. The foundations should be founded on the firm to dense natural soils, very dense decomposed rock, or on new compacted structural fill. The existing natural soils are considered suitable for the support of slabs on grade, provided that the subgrade soils have been properly prepared, as described in this report, and approved by the Geotechnical Engineer or their authorized representative.

Foundation Recommendations

Based on the test borings, the soils anticipated at foundation subgrade levels are expected to consist of natural firm to dense SILT (ML) or Sandy SILT (ML), or very dense decomposed rock. New compacted structural fill is also expected in some areas. Based on the results of the subsurface exploration, recommendations outlined in the "**Earthwork Operations**" section, and our engineering analysis, the proposed structures can be supported on traditional spread footing foundations when founded on suitable dense natural soils or decomposed rock. When loose to firm natural soils or new compacted fill is expected to be present at proposed footing subgrades, spread footings should be supported on geopiers or stone columns. General locations of the recommended foundation types can be found on the Foundation Type Location Diagram included in the Appendix.

Spread Footings

The geotechnical analysis of the soil indicates that footings supported on the dense natural silty soils or very dense decomposed rock may be designed for a bearing pressure of 10,000 psf. The soils suitable for support of a 10,000 psf bearing capacity may be identified on our boring logs as those natural materials having a minimum SPT N-value of 40 bpf or higher.

Based on the structural loading provided to us and limited settlement tolerance, we believe that normal spread footings may not be feasible in some areas due to the low available bearing pressures on the firm to medium dense natural soils or new compacted fill. We recommend that

footings in these areas be supported on geopiers or stone columns. The net allowable soil bearing pressure refers to that pressure which may be transmitted to the foundation bearing soils in excess of the final minimum surrounding overburden pressure.

Spread Footings on Geopiers/Stone Columns

Considering building column loads up to 600 kips, limited settlement tolerances, and the presence of softer natural silty soils and new structural fill at planned nominal footing grade, spread footings founded on structural fill or underlying firm to medium dense natural silt soils are not considered feasible. It may be more feasible to install shallow spread footing foundations over Geopiers or stone columns.

Geopier foundations or stone columns are recommended to reinforce the subsoils in areas which will require new fill, or with looser existing soils, in order to support high capacity shallow spread footings. The Geopier foundation systems, or stone columns, are practical refinements to the traditional over-excavation and replacement method of strengthening subsoils for settlement control and bearing capacity improvement. Geopier support elements or stone columns are constructed by drilling a hole to create a cavity, removing a volume of compressible or unsuitable subsoil materials, then building a bottom bulb of clean, open graded stone while vertically prestressing and prestraining subsoils underlying the bottom bulb.

For support of the building, Geopier elements, or stone columns, with minimum shaft lengths of about 15 feet can be expected to provide a support capacity of approximately 6,000 psf for spread footings. A minimum of eight 30-inch diameter geopiers or stone columns will be necessary to support a 600 kip column load and limit total settlement to less than one-half inch. The minimum footing size necessary to accommodate the geopier or stone column elements would be 10 feet. It should be noted that new compacted structural fill should be placed before installation of the geopiers or stone columns.

We recommend that you contact Mr. Ed O'Malley or Ms. Shana Opdyke with Geostructures, Inc. at (703) 771-9844 for Geopiers, or Mr. John Jones with Terra Systems at (540) 882-4130 for stone columns, to review and analyze the subsurface data contained in this report using available structural load and design information. After designing the support system, they will provide a full-scale Modulus Load Test on site to verify design assumptions. The test provides a conservative measure of the stiffness of the Geopier or stone column element and will help establish installation procedures for the project. ECS can coordinate with the Geopier of stone column installer to locate the load test in the weakest site area and provide full-time Quality Assurance monitoring services during the load test operations.

General

Settlement of individual footings, designed in accordance with the recommendations outlined above, is expected to be within tolerable limits for the proposed structures. Within the proposed

construction, total settlements on the order of one-half inch are anticipated, with differential settlement on the order of about half the total settlement. Due to multiple bearing capacities, footing elevations, and foundation types, settlement joints should be placed at each change in bearing capacity or foundation type. Additional construction and settlement joint locations should be analyzed and determined by the structural engineer.

In order to prevent disproportionately small footing sizes and to prevent shear failures, we recommend that continuous footings have a minimum width of 1.5 feet and that isolated column footings have a minimum lateral dimension of 2.5 feet. The minimum dimensions recommended above help reduce the possibility of foundation bearing failure and excessive settlement due to local shear or "punching" action. In addition, footings should be placed at a depth to provide adequate frost cover protection. Therefore, perimeter footings subject to freezing should be placed at a minimum depth of 2.5 feet below finished grade.

Seismic Site Class

Based on subsurface conditions encountered at the site, we recommend the following site coefficients for seismic design based on Section 1604 and 1613 of the International Building Code (2006) and spectral response acceleration values obtained from the Earthquake Hazards Program at the United States Geological Survey (USGS):

Seismic Site Class	C
Spectral response acceleration at short periods, S_s	0.15777g
Spectral response acceleration at 1-second period, S_1	0.05064g
Site coefficient, F_a	1.2
Site coefficient, F_v	1.7
Occupancy Category	Group III
Seismic Design Category	A

Based on information obtained from our soil test borings, and our review and knowledge of local geology, it is our opinion that the potential for liquefaction of the soil at the site due to earthquake activity is low.

Floor Slab Design

According to the test borings and based on existing grades, the soils anticipated below the floor slabs should consist of firm to dense natural sandy silt or decomposed rock. New compacted engineered fill is also anticipated in some areas. These soils are expected to be suitable for support of the floor slabs. The floor slab subgrade should be prepared in accordance with our recommendations outlined in the section entitled "**Earthwork Operations**", which includes stripping and fill placement. A modulus of subgrade reaction, k, of 150 pounds per cubic inch may be utilized in the design of floor slabs.

We recommend that floor slabs be isolated from the foundation footings so that differential settlement of the structures will not induce stresses on the floor slab. Also, in order to minimize the crack width of any shrinkage cracks that may develop near the surface of the slab, we recommend mesh reinforcement be included in the design of the floor slab. The mesh should be in the top half of the slab to be effective.

We recommend that a capillary cutoff layer be provided under the floor slab to prevent the rise of moisture through the floor slab. The capillary layer should consist of a minimum of 4 inches of clean crushed stone or washed gravel, with a maximum 2% fines passing the No. 200 sieve. AASHTO No. 57 stone should be suitable for this purpose. A vapor barrier should be placed on top of the stone to provide additional moisture protection. Placement of this vapor barrier should occur immediately before the placement of floor slab concrete in order to minimize damage to the layer. However, special attention should be given to the surface curing of the slab in order to minimize uneven drying of the slab and associated cracking.

Waterproofing

We recommend that perimeter underdrains be installed along all exterior footings to collect infiltrating water from surface flow. If the drainage system is eliminated, we recommend that below grade walls be waterproofed where necessary.

It should be noted that the existing groundwater level at the site was observed to be much deeper than expected lowest foundation levels and that waterproofing may not be necessary in all areas.

Below Grade Walls

Below grade walls should be designed to withstand lateral earth pressures at at-rest conditions and any surcharge loads within a 45 degree slope from the base of the wall. We recommend that the below grade walls be designed for a linearly increasing lateral earth pressure of 60 psf per vertical foot of wall. This lateral earth pressure assumes that the on-site silty or sandy soils, or crushed stone is used for wall backfill, and that the backfill is flat. Surcharge loading within a 45 degree slope from the bottom of the wall should be applied with a combined active and at rest pressure coefficient of 0.42. In order to maintain a 60 psf lateral earth pressure, drainage of the backfill of the proposed building must be provided.

A lateral passive earth pressure of 350 psf per foot of soil may be used for design. The passive resistance should be neglected to a depth of 2.5 feet in areas exposed to freezing conditions and in areas where there is a possibility that the soil in front of the wall will become disturbed or be excavated at any time in the future. Considering the relatively fine-grained soils, which may constitute the wall foundation bearing subgrade, a friction factor of 0.40 is recommended for sliding resistance analysis.

To achieve a desirable balance between minimizing excessive pressures against the below grade walls and reducing the settlement of the wall backfill, we recommend that the wall granular

backfill be compacted to 95% of the maximum dry density obtained in accordance with ASTM Specification D-698, Standard Proctor Method.

Backfill materials should consist of inorganic materials classified SM, SC or more granular per ASTM D-2487 that are free of debris. The fill placed adjacent to the below grade walls should not be overcompacted. Heavy earthwork equipment should maintain a minimum horizontal distance away from the below grade walls of 1 foot per foot of vertical wall height. Lighter compaction equipment should be used close to the below grade walls.

If suitable backfill soils are not available then man-made drainage materials may be used adjacent to the below grade walls. Examples of suitable materials include Enka Mat, Mira Drain, or Geotec Drains. These materials should be covered with a filter fabric having an apparent opening size (AOS) consistent with the size of the soil to be retained. The material should be placed in accordance with the manufacturer's recommendations and connected to either the perimeter drainage system or the underslab granular mat, which in turn should be properly drained.

Retaining Walls

Retaining walls may be required to achieve planned site grades. All retaining walls that are free to rotate at the top must be designed to resist active lateral earth pressures. Retaining walls may be designed for an active lateral pressure of 40 psf per foot of wall height. This value assumes level backfill behind the walls and does not include the influence of any surcharge loads. Any surcharge loads imposed within a 45 degree slope of the base of the walls should be considered in the below grade wall design. Additionally, a lateral passive earth pressure of 350 psf per vertical foot of soil may be used in the design. The passive resistance on the walls should be neglected if there is a possibility that the soil in front of the wall will be excavated at any time in the future. Considering the relatively fine-grained soils anticipated at the wall foundation bearing level, a friction factor of 0.40 is recommended for sliding resistance analysis.

The parameters recommended above also assume that freely draining materials are used to backfill the walls and that adequate drainage will be provided at the base of the walls. Drainage of retaining walls may be accomplished through the use of 3-inch diameter weep holes spaced about 8 to 10 feet, penetrating the wall, immediately above the proposed grade in front of the wall. Alternatively, a longitudinal drain line may be placed behind the retaining wall, sloped to discharge by gravity to daylight or to a storm sewer.

Earthwork Operations

Proper monitoring of newly placed fill with respect to lift thickness and compaction of each lift is expected to be necessary at this site. The following paragraphs detail our recommendations regarding earthwork operations.

Fill, Floor and Pavement Subgrades

The existing ground surface in the proposed structural areas should be stripped of all vegetation, rootmat, topsoil, and any soft or unsuitable material. The stripping within the proposed structural areas should be extended to at least 10 feet, where possible, beyond the planned limits.

After stripping to the desired grade, performing all necessary excavation, and prior to fill and/or stone base placement, the exposed soils should be carefully examined to identify any localized loose, yielding, or otherwise unsuitable materials by an experienced Geotechnical Engineer or their authorized representative. After examining the exposed soils, loose and yielding areas should be identified by proofrolling with an approved piece of equipment, such as a loaded dump truck, having an axle weight of at least 10 tons. Any soft or unsuitable materials encountered during this proofrolling should be removed and replaced with an approved engineered fill compacted to the criteria given below.

The preparation of fill subgrades, as well as proposed building and pavement subgrades, should be observed by an experienced geotechnical engineer, or their representative, to verify that all unsuitable materials have been removed, and that the subgrade is suitable for support of the proposed construction and/or fills. In some areas, excessively soft and/or wet soils may be encountered for fill subgrades, especially in the winter or early spring months. Soft, yielding areas shall be over-excavated and replaced.

Fill Placement

Compacted engineered fill and backfill for utilities or undercuts should consist of soils classified as ML, SM, SC or more granular per ASTM D-2487 and have a liquid limit less than 45 and plasticity index less than 20. Unacceptable backfill materials include topsoil, organic materials (OH, OL) and high plasticity silts and clays (MH, CH). All such materials removed during grading operations should be either stockpiled for later use in landscape fills, or placed in approved disposal areas either on site or off site.

An examination of the soils recovered during our current exploration and our previous experience in the area indicates that a majority of the on-site Sandy SILT (ML) soils should generally be suitable for reuse as controlled, compacted fill, with moisture adjustment during placement. The existing fill material should be suitable for reuse as long as it is free of any deleterious material and meets the above guidelines.

All fill should be placed in loose lifts, not exceeding 8 inches in thickness, and should be compacted to at least 95 percent of the maximum dry density, as determined by the Standard Proctor Compaction Test (ASTM D-698). Generally, the moisture content of the fill materials should be maintained within 2 percent of the optimum moisture content for the fill material, as determined by ASTM D-698. Fill placed in non-structural areas (e.g. grassed areas) should be compacted to at least 90 percent of the maximum dry density according to ASTM D-698, in order to avoid significant subsidence. The upper 12 inches of soil supporting slabs-on-grade and

pavements should be compacted to a minimum of 100% of the maximum dry density obtained in accordance with ASTM D-698, Standard Proctor Method discussed above.

Excavation Support Requirements

Excavation to the lowest floor level will involve cuts up to approximately 16 feet below existing surface grades. Sheeting will most likely be required around the western perimeter of the site, as well as portions of the north and south sides.

A free drainage sheeting system with H beams, wood lagging, and appropriate bracing is considered feasible. Rakers and heel blocks will probably be necessary in areas where tiebacks are not feasible. H beams would normally be spaced at 8 feet on center and driven to at least 5 feet below lowest excavation levels. Wood lagging should be at least 3 inches in thickness. Tiebacks would be feasible for most of the excavation. Soldier beams must be designed for vertical loads developed from the prestressed tiebacks.

Rock Excavation/Blasting Operations

Material requiring rock excavation methods was encountered in some of the borings. However, materials requiring rock excavation techniques were encountered at depths greater than the expected footing elevations and utility trenches, except for the area near boring B-1. Material requiring rock excavation techniques was encountered at a depth of 8.5 feet, or EL 560, in this area.

If deeper excavations are deemed necessary, we recommend that for budgeting purposes rock excavation be considered necessary where SPT-N values exceed 50/3 (i.e. 50/2, 50/1, etc.) or where auger refusal was encountered in the borings before such SPT-N values were encountered.

For the design, construction planning, and final pay quantities, we recommend that the following definition be used to define hard rock excavation material for the project specification:

> "Rock shall be defined as those natural materials which cannot be excavated in an open excavation with a Caterpillar Model D-8, heavy duty track-type tractor, weighted at not less than 285 hp flywheel power and equipped with a single-shank hydraulic ripper, capable of exerting not less than 45,000 lbs. breakout force, or equivalent machinery. For trenches and pits, rock shall be defined as those materials that cannot be excavated with a Caterpillar Model No. 345 L track-type hydraulic excavator, weighing not less than 99,000 lbs., equipped with a 30-inch wide short-tip radius rock bucket, rated at not less than 345 hp flywheel power with bucket-digging force of not less than 39,000 lbs., or equivalent machinery. Boulders or masses of rock exceeding one-half cubic yard in volume shall also be considered rock excavation. This classification does not include materials such as loose rock, concrete, or other materials that can be removed by means other than

drilling and blasting, rock trenching, or hoe-ramming, but which for reasons of economy in excavating, the contractor chooses to remove by drilling and blasting, rock trenching, or hoe-ramming techniques."

It is important that the appropriate contractors be provided a copy of the complete geotechnical report, including the associated subsurface data, and any other geotechnical reports, in order to ensure that the contractors are familiar with the site subsurface conditions and the appropriate equipment is utilized for the project.

Pavement Recommendations

One pavement core (noted as core sample 1 on the Boring Location Diagram) was conducted along Observation Drive to evaluate the condition of the existing pavement. The existing pavement section consisted of 3 inches of asphalt underlain by 5 inches of stone base. The existing pavement was considered to be in fair condition. Due to some loose soils at pavement subgrades, we recommend that the pavement section be redesigned for new traffic loads.

For design of new pavements the on-site natural soils should provide poor to fair pavement support characteristics. For design of pavements, we recommend a CBR value of 1 to 3 for these soils. CBR testing should be conducted on the actual subgrade soils during construction to verify CBR values. All pavement subgrades should be prepared in accordance with the recommendations in the section entitled **"Earthwork Operations"**.

For the design and construction of exterior pavements, we recommend that the existing ground surface in the proposed pavement areas be stripped of all vegetation, rootmat, topsoil, and any other soft or unsuitable material. The stripping within the proposed structural areas should be extended to at least 10 feet, where possible, beyond the planned limits.

After stripping to the desired grade, performing all necessary excavation, and prior to fill and/or stone base placement, the exposed soils should be carefully examined to identify any localized loose, yielding, or otherwise unsuitable materials by an experienced Geotechnical Engineer or their authorized representative. After examining the exposed soils, loose and yielding areas should be identified by proofrolling with an approved piece of equipment, such as a loaded dump truck, having an axle weight of at least 10 tons. Any soft or unsuitable materials encountered during this proofrolling should be removed and replaced with an approved engineered fill compacted to the criteria given in the **"Earthwork Operations"** section of this report.

The preparation of fill subgrades, as well as proposed building and pavement subgrades, should be observed by an experienced geotechnical engineer, or their representative, to verify that all unsuitable materials have been removed, and that the subgrade is suitable for support of the proposed construction and/or fills. In some areas, excessively soft and/or wet soils may be encountered for fill subgrades, especially in the winter or early spring months. Soft, yielding areas shall be over-excavated and replaced.

An important consideration in the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the base course layer, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Furthermore, good drainage should minimize the possibility of the subgrade materials becoming saturated over a long period of time.

Construction Considerations

Precautionary measures should be taken to ensure that preparation of the subgrade and footing bearing surfaces are accomplished by the recommended procedures. These precautions are necessary, as the materials observed in the borings will become weakened if exposed to water. Therefore, we recommend that all excavations be properly dewatered, if necessary, using conventional sump pit and pumping operations. The site should be graded such that surface water runoff is directed away from the excavations.

Exposure to the environment may weaken the soils at the footing bearing level if foundation excavations remain open for extended periods of time. Therefore, foundation concrete should be placed the same day that footings are excavated. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, we recommend that a 1-to 3-inch thick "mud-mat" of "lean" concrete be placed on the bearing soils before the placement of reinforcing steel.

The on-site soils contain fines which are considered moderately erodible. The Contractor should provide and maintain good site drainage during earthwork operations to help maintain the integrity of the surface soils. The surface of the site should be kept properly graded in order to enhance drainage of the surface water away from the proposed construction areas during the earthwork phase. Other practices would involve sealing the exposed soils daily with a smooth drum roller to reduce the potential for infiltration of surface water in the exposed soils. All erosion and sedimentation shall be controlled in accordance with sound engineering practice and current County requirements.

In their undisturbed state, the upper soils at the site will generally provide fair subgrade support for fill placement and construction operations. However, when disturbed or wet, these soils will degrade quickly with disturbance from contractor operations. Therefore, good site drainage should be maintained during earthwork operations, which will help maintain the integrity of the soil.

Closing

This report has been prepared to aid in the evaluation of this site and to assist the design team with the design of the proposed residence. The report scope is limited to this specific project and the location described. The project description represents our current understanding of the significant aspects of the proposed improvements relevant to the geotechnical considerations.

We have appreciated the opportunity to be of service to The Lukmire Partnership and hope to continue our involvement on the project during the final design and construction phases. ECS is capable of providing all construction materials testing services for the project, and we would appreciate the opportunity to offer our services.

APPENDIX

Site Location Diagram

Lateral Earth Pressure Diagram

Unified Soil Classification System

Laboratory Test Results

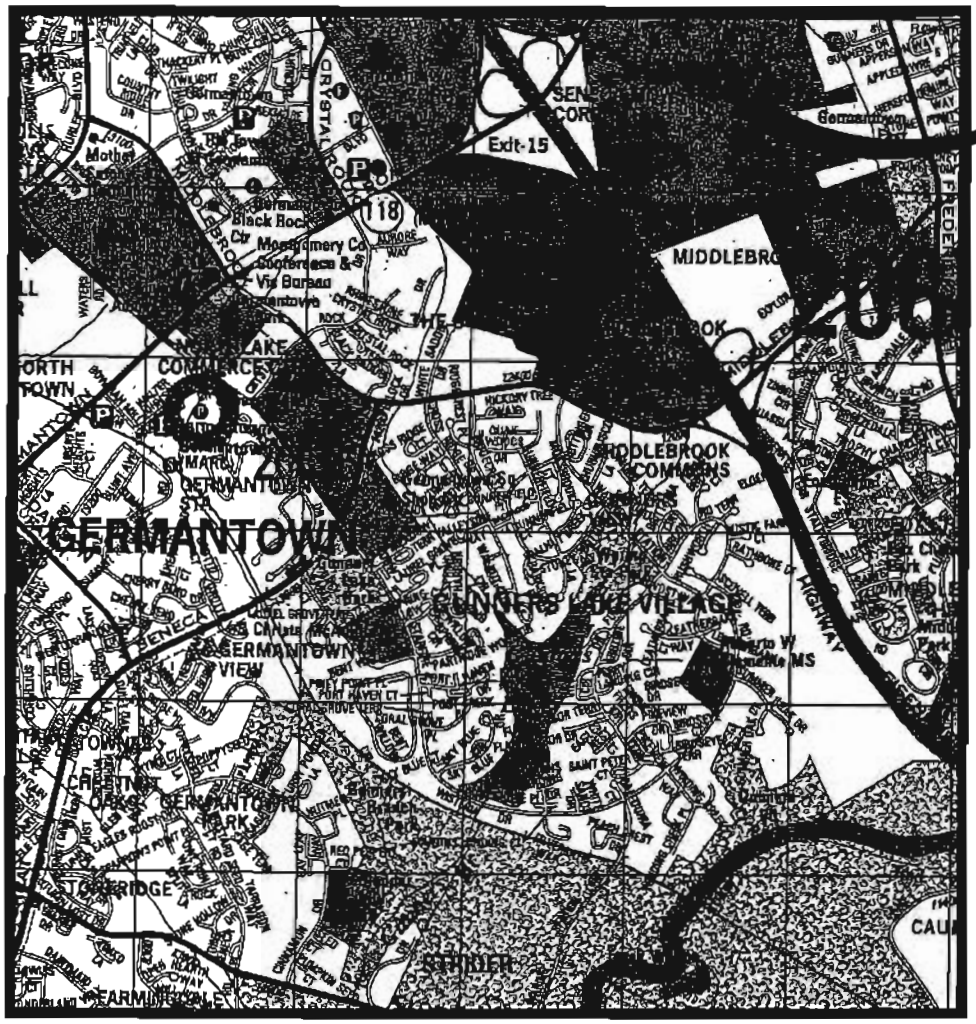
Reference Notes for Boring Logs

Boring Logs (B-1, through B-12 and P-1 through P-3)

Cross Section Diagrams (A-A' and B-B')

Foundation Type Location Diagram

Boring and Cross Section Location Diagram



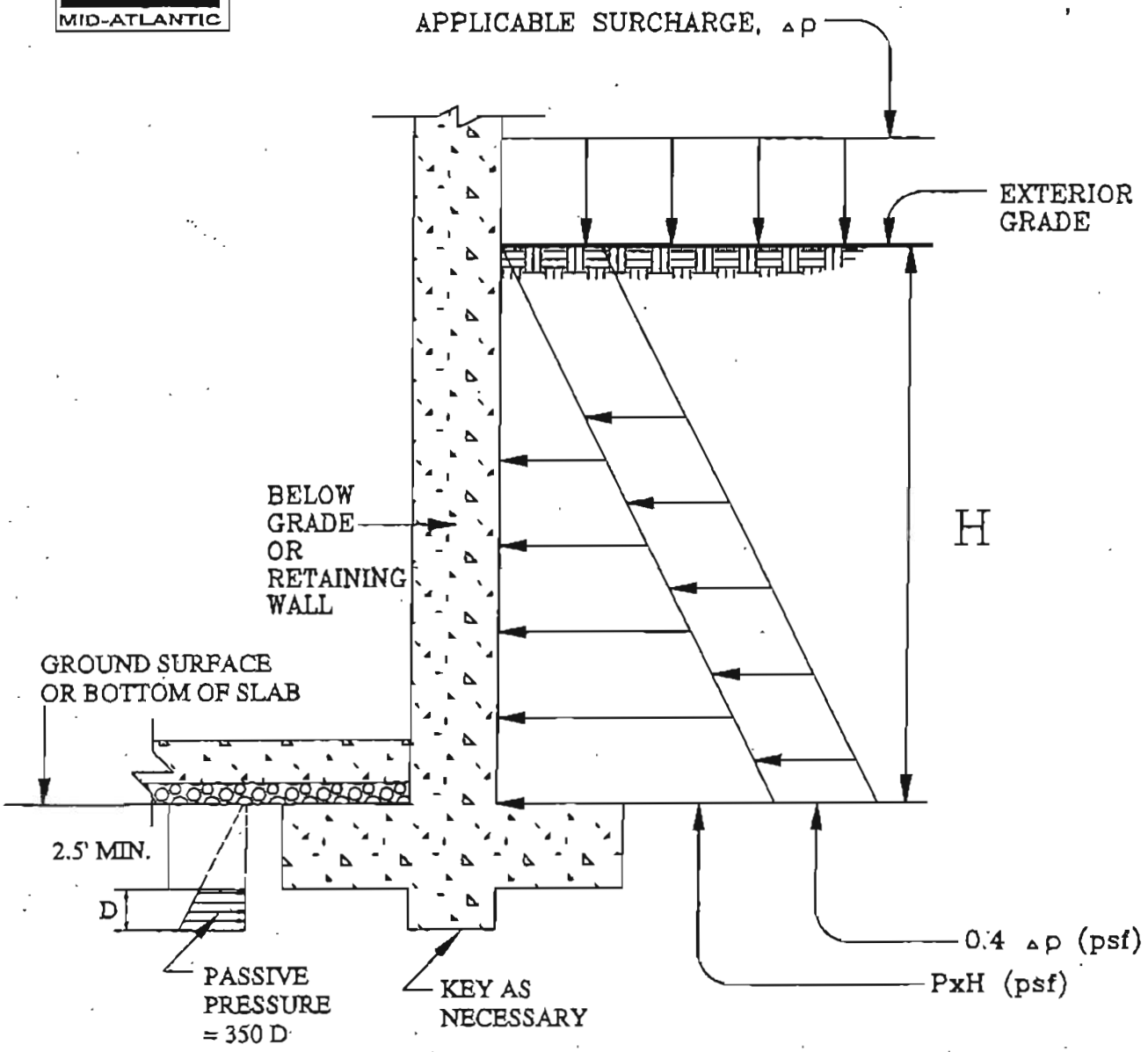
ECS LLC
MID-ATLANTIC

SITE LOCATION DIAGRAM
MONTGOMERY COLLEGE BIOSCIENCE CENTER

THE LUKMIRE PARTNERSHIP

AMH	GAR	06-19-08	NTS	13-3361	1 OF 1

ECS LLC
MID-ATLANTIC



LEGEND:

P = LATERAL EARTH PRESSURE (60 plf) FOR RIGID WALLS
(40 plf) FOR RETAINING WALLS

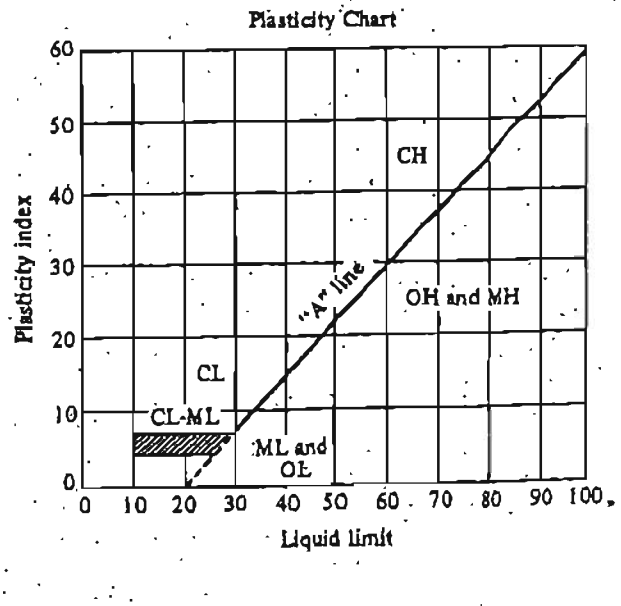
LATERAL EARTH PRESSURE DIAGRAM ©

FOR BELOW GRADE & RETAINING WALLS

Unified Soil Classification System (ASTM D-2487)

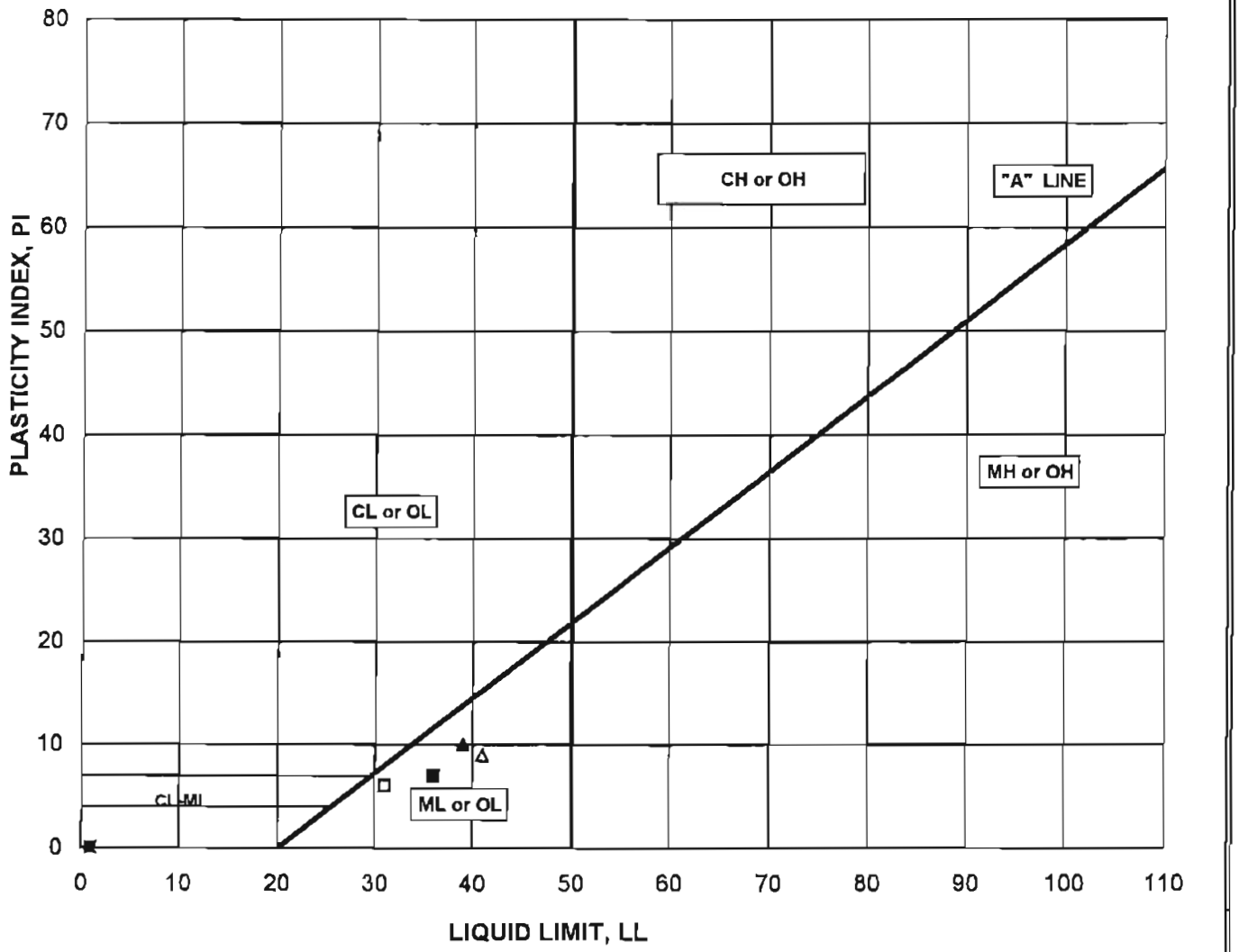
Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria	
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a] d / u	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits below "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a] d / u	Silty sands, sand-silt mixtures	Atterberg limits above "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			OL	Organic silts and organic silty clays of low plasticity		
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			CH	Inorganic clays of high plasticity, fat clays		
			OH	Organic clays of medium to high plasticity, organic silts		
	Highly organic soils		Pt	Peat and other highly organic soils		

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:
Less than 5 per cent — GW, GP, SW, SP
More than 12 per cent — GM, GC, SM, SC
5 to 12 per cent — *Borderline* cases requiring dual symbols[b]



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.
[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

From Winterkorn and Fang, 1975



BORING/ SAMPLE No.	DEPTH (feet)	TEST SYMBOL	DESCRIPTION	WATER CONTENT (%)	LL	PL	PI
B-2 / BAG	2'-10'	□	ORANGISH BROWN SANDY SILT WITH GRAVE	5.1	31	25	6
B-5 / BAG	2'-10'	■	ORANGISH BROWN SANDY SILT	10.2	36	29	7
B-7 / BAG	2'-10'	△	ORANGISH BROWN SANDY SILT	12.2	41	32	9
B-9 / BAG	2'-10'	▲	BROWN SANDY SILT	12.1	39	29	10
/		X			-	-	-
/		○			-	-	-
/		●			-	-	-
/		◇			-	-	-
/		◆			-	-	-
/		+			-	-	-
		X					

Applicable ASTM: D-4318

Project: MONTGOMERY COLLEGE BIOSCIENCE CTR

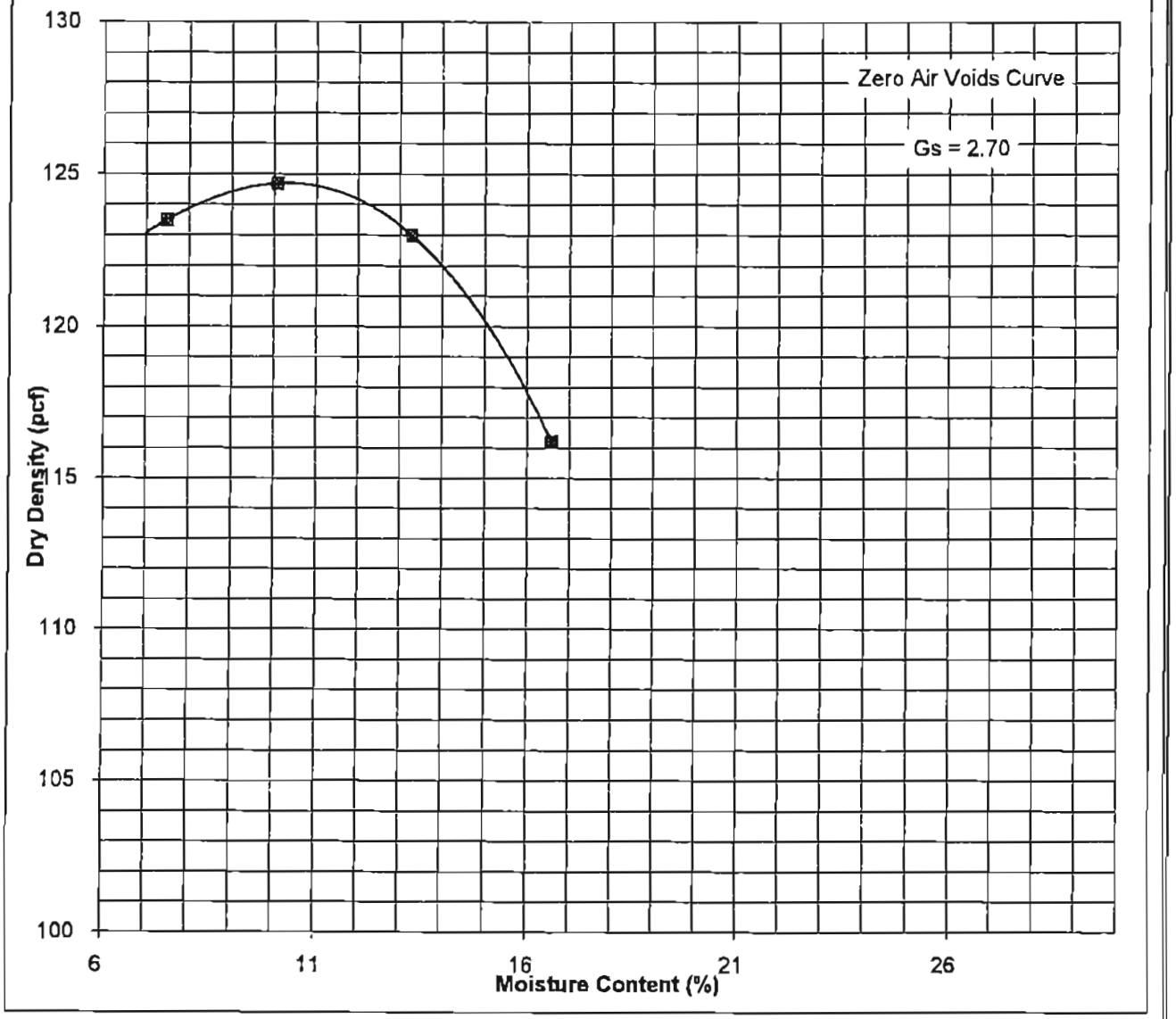
Project No.: 3361

Date: 06/09/2008

ECS - MID ATLANTIC LLC

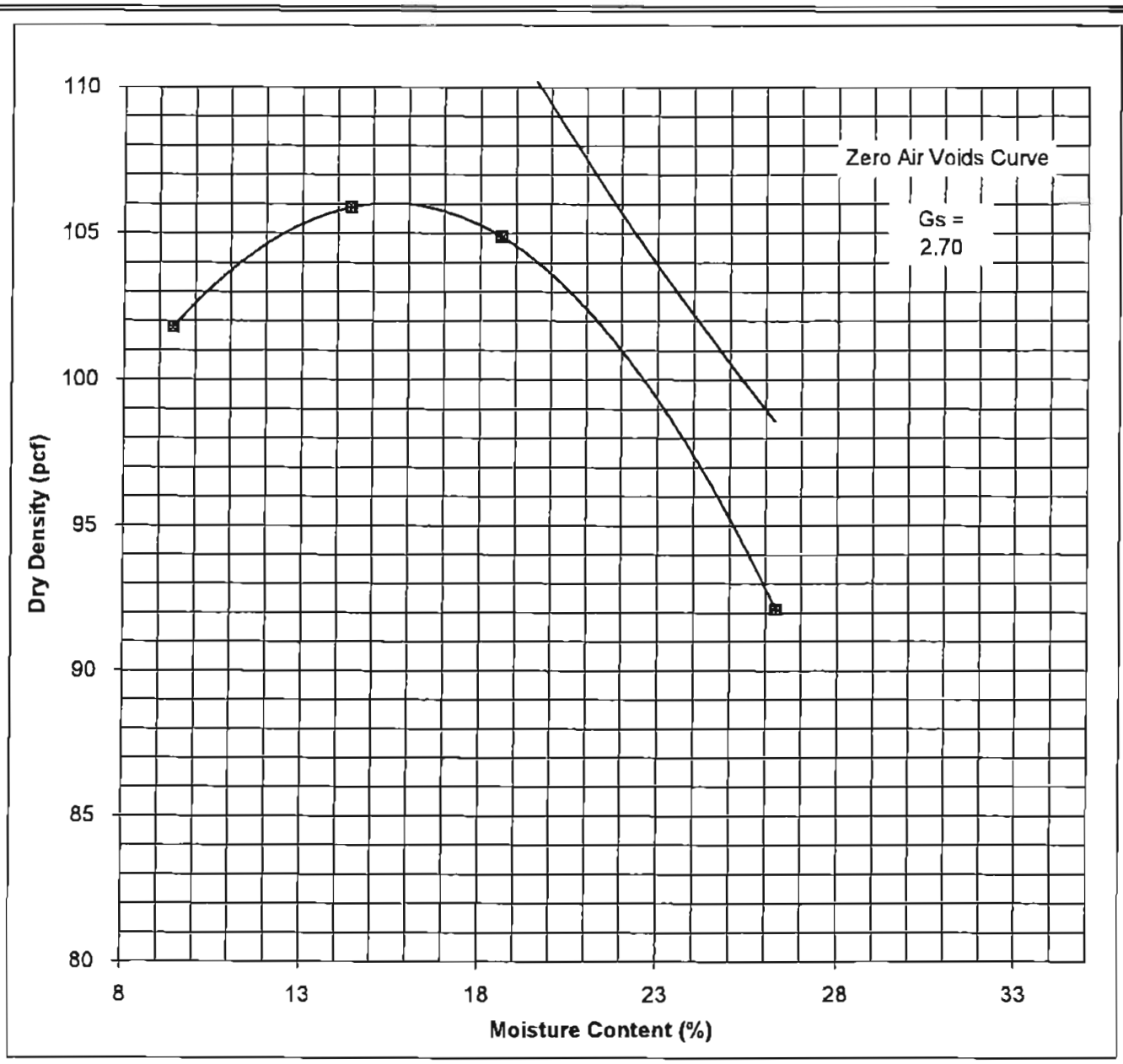
Frederick, Maryland

Plasticity Chart



Sample No.	B2-BAG	Natural Moisture Content	5.1
Street		Percent Passing No. 200 Sieve	30.4
Station		Percent Retained on No. 4 Sieve	27.8
Liquid Limit (LL)	31	Percent Retained on 3/4" Sieve	10.8
Plastic Limit (PL)	25	Maximum Dry Density (pcf)	124.7
Plasticity Index (PI	6	Optimum Moisture Content (%)	10.6
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	131.5
Description	ORANGISH BROWN SANDY SILT WITH GRAVEL	Corr. Optimum Moisture Content (%)	8.9
Classification	ML	Percent (%) Gravel as Tested	7.9
Specific Gravity	2.70	Percent (%) Gravel Total	27.8
Test Standard	D-698	Test Method	B

Project: MONTGOMERY COLLEGE BIOSCI	**ECS MID-ATLANTIC, LLC**
Project No.: 3361	**Frederick, Maryland**
Date: 6/9/08	**Moisture Density Relationship Curve**



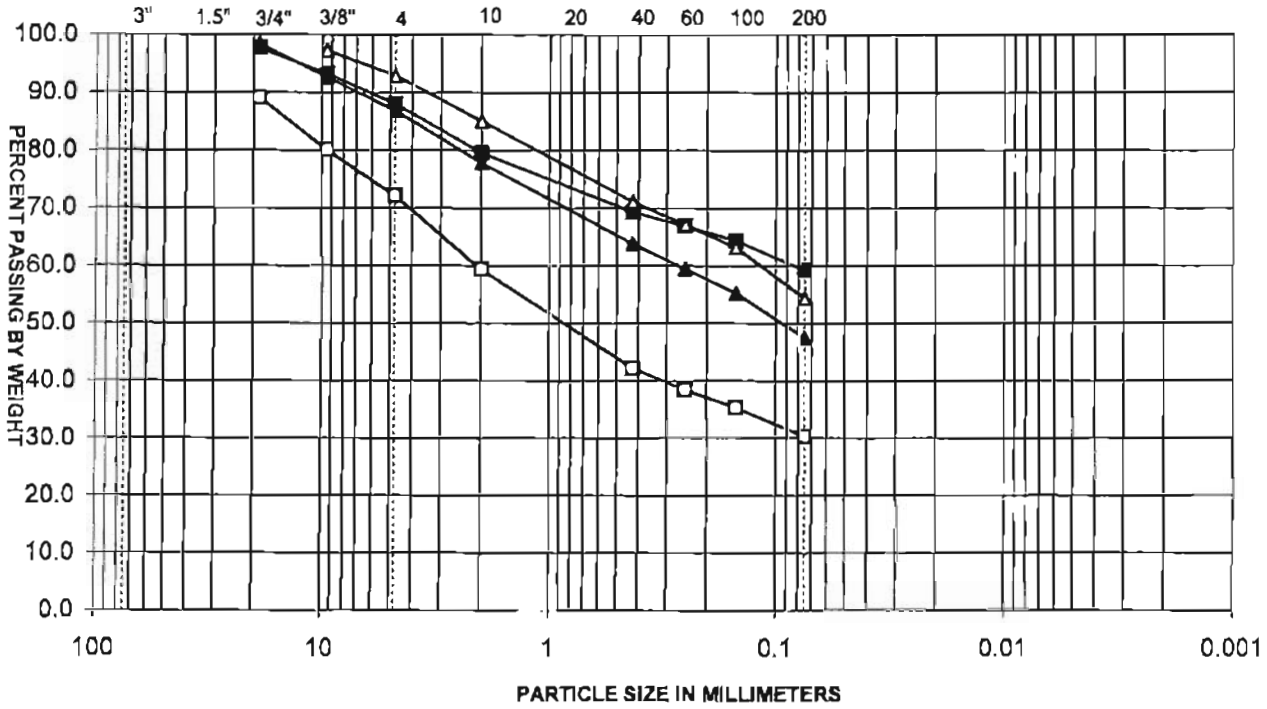
Sample No.	B7-BAG	Natural Moisture Content	12.2
Street		Percent Passing No. 200 Sieve	54.4
Station		Percent Retained on No. 4 Sieve	7.0
Liquid Limit (LL)	41	Percent Retained on 3/4" Sieve	0
Plastic Limit (PL)	32	Maximum Dry Density (pcf)	106.0
Plasticity Index (PI)	9	Optimum Moisture Content (%)	15.5
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	108.8
Description	ORANGISH BROWN SANDY SILT	Corr. Optimum Moisture Content (%)	14.6
Classification	ML	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.70	Percent (%) Gravel Total	7.0
Test Standard	D-698	Test Method:	A

Project: MONTGOMERY COLLEGE BIOSCIE
Project No.: 3361
Date: 6/9/08

ECS MID-ATLANTIC, LLC
Frederick, Maryland
Moisture Density Relationship Curve

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S. STANDARD SIEVE OPENING IN INCHES	U.S. STANDARD SIEVE NUMBERS	HYDROMETER



Boring/ Sample No.	Depth (feet)	Symbol	LL	PI	Description
B-2 / BAG	2'-10'	□	31	6	ORANGISH BROWN SANDY SILT WITH GRAVEL
B-5 / BAG	2'-10'	■	36	7	ORANGISH BROWN SANDY SILT
B-7 / BAG	2'-10'	△	41	9	ORANGISH BROWN SANDY SILT
B-9 / BAG	2'-10'	▲	39	10	BROWN SANDY SILT

Project: MONTGOMERY COLLEGE BIOSCIENCE

Project No.: 3361

Date: 26-Jun-08

ECS - Mid-Atlantic, LLC

Frederick, Maryland

Grain Size Analysis

REFERENCE NOTES FOR BORING LOGS

I. Drilling Sampling Symbols:

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, BX, AX	PM	Pressuremeter
DC	Dutch Cone Penetrometer	RD	Rock Bit Drilling
BS	Bulk Sample of Cuttings	PA	Power Auger (no sample)
HAS	Hollow Stem Auger	WS	Wash Sample

II. Correlation of Penetration Resistances to Soil Properties:

Standard Penetration (Blows/Ft) refers to the blows per foot of a 140 lb. Hammer falling 30 inches on a 2-inch OD split spoon sampler, as specified in ASTM D-1586. The blow count is commonly referred to as the N value.

A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

Density		*Relative Properties*	
Under 3 blows/ft.	Very Loose	Adjective Form	36% to 49%
4 to 6 blows/ft.	Loose	With	21% to 35%
7 to 10 blows/ft.	Firm	Some	11% to 20%
11 to 30 blows/ft.	Medium Dense	Trace	1% to 10%
31 to 50 blows/ft.	Dense		
51 to 80 blows/ft.	Very Dense		
Over 80 blows/ft.	Extremely Dense		

Particle Size Identification

Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ inch
Sand	Coarse	2.00mm to ¼ inch (dia. of lead pencil)
	Medium	0.42 to 2.00mm (dia. of broom straw)
	Fine	0.074 to 0.42mm (dia. of human hair)
Silt and Clay		0 .0 to 0.074mm (particles cannot be seen)

B. Cohesive Soils (Clay, Silt, and Combinations)

Blows/Ft	*Consistency*	*Unconfined Comp. Strength Q_P(tsf)*	*Degree of Plasticity*	*Plasticity Index*
Under 4	Very Soft	Under 0.25	None to Slight	0 - 4
4 to 5	Soft	0.25-0.49	Slight	5 – 7
6 to 10	Med. Stiff	0.50-0.99	Medium	8- 22
11 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.00		
31 to 50	Hard	4.00-8.00		
Over 51	Very Hard	Over 8.00		

III. Water Level Measurement Symbols

WL: Water Level Encountered While Drilling
WL(BCR): Water Level at Completion Before Auger or Casing Removal
WL(ACR): Water Level after Auger or Casing Removal

The water levels are those water levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally applied.

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% — 40% — 60% — 80% — 100%

STANDARD PENETRATION BLOWS/FT. ⊗ (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ● — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 568.58

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	18	Gravel Depth 2"		23 (18-11-12)
					Sandy SILT, Trace Gravel, Grayish Brown, Moist, Medium Dense, (ML-FILL)	565	24 (6-8-16)
5	2	SS	18	18			10.2
	3	SS	18	18	Sandy SILT, With Decomposed Rock and Rock Fragments, Brownish Gray and Reddish Brown, Moist, Medium Dense, (ML)		24 (12-12-12)
							14.1
	4	SS	3	3	Decomposed Rock and Rock Fragments, Gray, Moist, Very Dense	560	(50/3) 50
10	5	SS	0	0			(50/0) 50/0
					AUGER REFUSAL @ 9.0'	555	
15							
						550	
20							
						545	
25							
						540	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR ▽D	BORING STARTED 06-03-08	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 06-03-08	CAVE IN DEPTH ● 16.0'
▽WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AWEWIT (08-25-08) AWEWIT (08-26-08)

gpjlibrary(08/15/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)
PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △
ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.% ——— (20% 40% 60% 80% 100%)
STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS
BOTTOM OF CASING — LOSS OF CIRCULATION (100%)
SURFACE ELEVATION 565.62

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)
0	1	SS	18	18	565
					Topsoil Depth 3"
	2	SS	18	16	Sandy SILT, Trace Gravel, Trace Clay, Trace Mica, Reddish Brown, Moist, Firm, (ML-FILL)
5	3	SS	18	16	560 Decomposed Rock and Rock Fragments, With Sandy SILT, Brownish Gray, Moist, Very Dense
	4	SS	18	16	
10					555
	5	SS	6	4	
15					550
	6	SS	0	0	AUGER REFUSAL @ 18.0'
20					545
25					540
30					

8 (4-4-4)
5.1
25 31
17 (3-4-13)
14.7
(13-24-50/6) 50/6
(15-38-40) 78
(50/6) 50/6
(50/0) 50/0

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 06-03-08	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 06-03-08	CAVE IN DEPTH ● 15.0'
▽WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

ARCBITT (08-25-08) ARCBITT (08-26-08)
grdlog-a1(08/16/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)
PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ
ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.% ——— (20% 40% 60% 80% 100%)
STANDARD PENETRATION BLOWS/FT. (⊗) (10 20 30 40 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS
BOTTOM OF CASING — LOSS OF CIRCULATION (100%)
SURFACE ELEVATION 571.17

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	16	Gravel Depth 6"		570	9 (12-4-5)
					Sandy SILT, Trace Gravel, Reddish Brown, Moist, Firm, (ML-FILL)			10.5
	2	SS	18	18				11 (4-5-6)
5					Sandy SILT, With Decomposed Rock, Trace Rock Fragments, Reddish Brown, Moist, Firm to Dense, (ML)			10.3
	3	SS	18	18			565	6 (3-3-3)
								20.4
	4	SS	18	16				(13-18-16) 34
10							560	
	5	SS	6	6	Decomposed Rock and Rock Fragments, With Sandy Silt, Gray, Moist, Very Dense			(50/6) 50/6
15							555	
	6	SS	0	0	AUGER REFUSAL @ 17.5'			(50/0) 50/0
20							550	
25							545	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 06-03-08	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 06-03-08	CAVE IN DEPTH ● 14.5'
▽WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

ANEWITT (08-25-08) ANEWITT (06-26-08)
gridsheet(06/15/2006)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-4	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % (X) — WATER CONTENT % (●) — LIQUID LIMIT % (Δ)

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (⊗)
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION (100%)

SURFACE ELEVATION 575.71

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	18	Topsoil Depth 4"	575	13 (5-8-7)
					Sandy SILT, Trace Clay, Trace Gravel, Trace Rock Fragments, Trace Roots, Reddish Brown, Moist, Medium Dense, (ML-FILL)		12.5
	2	SS	18	18			7 (2-4-3)
5	3	SS	18	18	Sandy SILT, With Decomposed Rock and Rock Fragments, Grayish Brown, Moist, Firm to Dense, (ML)	570	8 (3-3-5)
	4	SS	18	18			(12-18-18) 34
10						565	
	5	SS	12	12	Decomposed Rock and Rock Fragments, With Sandy Silt, Gray, Moist, Very Dense		(23-50/6) 50/6
15						560	
	6	SS	18	16	Sandy SILT, With Decomposed Rock and Rock Fragments, Orangish Brown, Moist, Dense, (ML)		(5-6-27) 33
20						555	
	7	SS	15	14	Decomposed Rock and Rock Fragments, With Sandy Silt, Light Brown and Tan, Moist, Very Dense		(28-41-50/3) 50/3
25						550	
					END OF BORING @ 24.8'		
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 06-03-08	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 06-03-08	CAVE IN DEPTH ● 22.5'
▽WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AHEWITT (08-25-08) AHEWITT (08-26-08)

grabboard(08/16/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-5	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — REC.% —
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗
10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 569.92

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)
0	1	SS	18	10	Gravel Depth 6"	
					Sandy SILT, Trace Gravel, Trace Roots, Brown and Reddish Brown, Moist, Loose to Medium Dense, (ML-FILL)	
	2	SS	18	12		
5	3	SS	18	14	Sandy SILT, Trace Decomposed Rock, Reddish Brown, Moist, Firm, (ML)	565
	4	SS	18	18	Sandy SILT, With Decomposed Rock, Trace Rock Fragments, Reddish Brown to Orangish Brown, Moist, Medium Dense, (ML)	
10						560
	5	SS	18	18		
15						555
	6	SS	18	18		
20						550
	7	SS	18	18	Sandy SILT, With Decomposed Rock and Rock Fragments, Orangish Brown, Moist, Dense, (ML)	
25						545
	8	SS	18	18		
30						

⊗ 11 (10-7-4)
0.2 ✕ 29 △ 36
⊗ 6 (3-3-3)
⊗ 7 (2-2-5)
⊗ 16 (4-7-9)
⊗ 17 (7-7-10)
⊗ 12 (5-5-7)
(9-16-21) ⊗ 37
(13-18-23) ⊗ 41

CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY	WS OR WD	BORING STARTED 06-02-08	
▽WL(BCR) DRY ▽WL(ACR) DRY		BORING COMPLETED 06-02-08	CAVE IN DEPTH @ 40.0'
▽WL		RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AMENDED (08-25-08) AMENDED (08-28-08)
grabowski(08/18/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-5	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % (X) — WATER CONTENT % — LIQUID LIMIT % (Δ)

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION (100%)

SURFACE ELEVATION 569.92

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION
30					Sandy SILT, With Decomposed Rock and Rock Fragments, Orangish Brown, Moist, Dense, (ML)		
	9	SS	18	18	Decomposed Rock and Rock Fragments, With Sandy Silt, Orangish Brown, Moist, Very Dense	535	(25-28-33) 61
35							
	10	SS	18	18			(12-39-50/6) 50/6
40					AUGER REFUSAL @ 40.0'	530	
45						525	
50						520	
55						515	
60							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY	WS OR (ID)	BORING STARTED 06-02-08	
▽WL(BCR) DRY ▽WL(ACR) DRY		BORING COMPLETED 06-02-08	CAVE IN DEPTH @ 40.0'
▽WL		RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AGS WIT (08-25-08) AGS WIT (08-28-08)

grdlowrd(05/14/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-6	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 568.80

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	18	Topsoil Depth 2"		6 (2-2-4)
					Sandy SILT, Trace Clay, Trace Gravel, Trace Roots, Reddish Brown, Moist, Loose, (ML-FILL)		
	2	SS	18	18		565	16 (6-7-9)
5	3	SS	18	18	Sandy SILT, With Decomposed Rock, Trace Rock Fragments, Light Brown to Reddish Brown, Moist, Firm to Medium Dense, (ML)		7 (2-3-4)
	4	SS	18	16	Sandy SILT and Decomposed Rock, With Rock Fragments, Reddish Brown, Moist, Very Dense, (ML)	560	(14-21-30) 51
10							
	5	SS	18	16		555	(16-22-34) 56
15							
	6	SS	0	0			(50/0) 50/0
20					AUGER REFUSAL @ 18.0'	550	
25						545	
30						540	

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▼WL DRY WS OR WD	BORING STARTED 06-03-08	
▼WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 06-03-08	CAVE IN DEPTH ● 16.0'
▼WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AHDWIT (08-25-08) AHDWIT (08-25-08)

gintborehd(08/16/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-7	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 573.37

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	18	Topsoil Depth 3"			6 (2-2-4)
					Sandy SILT, Trace Gravel, Trace Roots, Brown, Moist, Loose, (ML-FILL)			12.2 ● 32 ✕ 41 △
	2	SS	18	18			570	8 (2-4-4)
5	3	SS	18	18	Sandy SILT, With Decomposed Rock, Reddish Brown, Moist, Firm to Medium Dense, (ML)			12 (5-8-6) 14.5 ●
	4	SS	18	18			565	20 (8-8-12)
10								
							560	
15	5	SS	18	16	Sandy SILT and Decomposed Rock, With Rock Fragments, Reddish Brown, Moist, Dense to Very Dense, (ML)			7.6 ● (9-14-27) 41
							555	
20	6	SS	18	18				(17-21-28) 49
							550	
	7	SS	18	18				(25-23-30) 53
25					END OF BORING @ 25.0'		545	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▼WL DRY	WS OR WD	BORING STARTED 06-03-08	
▼WL(BCR) DRY ▼WL(ACR) DRY		BORING COMPLETED 06-03-08	CAVE IN DEPTH @ 16.0'
▼WL		RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AWENITT (06-25-08) AWENITT (06-25-08) gpjtemplate(06/16/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-8	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % (X) — WATER CONTENT % (●) — LIQUID LIMIT % (Δ)

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (⊗)
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 559.44

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	DESCRIPTION OF MATERIAL	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	18		559	Topsoil Depth 4"	6 (3-3-3)
							Sandy SILT, Trace Gravel, Trace Roots, Reddish Brown, Moist, Loose, (ML-FILL)	
	2	SS	18	18				5 (2-2-3)
5	3	SS	18	18		555	Sandy SILT, With Decomposed Rock and Rock Fragments, Reddish Brown, Moist, Loose to Medium Dense, (ML)	8 (2-3-5)
	4	SS	18	18				20 (9-10-10)
10						550		
	5	SS	18	18		545		11 (6-6-5)
15								
	6	SS	18	18		540		9 (6-5-4)
20								
	7	SS	6	6		535	Decomposed Rock and Rock Fragments, With Sandy Silt, Light Brown, Moist, Very Dense	(50/6) 50/6
25								
						530	END OF BORING @ 24.0'	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY	WS OR ▽D	BORING STARTED 06-04-08	
▽WL(BCR) DRY ▽WL(ACR) DRY		BORING COMPLETED 06-04-08	CAVE IN DEPTH ● 21.5'
▽WL		RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AMERITY (06-25-08) AMERITY (06-26-08)

gradlowmd(08/18/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-9	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)
PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ
ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.% ——— (20% 40% 60% 80% 100%)
STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS
BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%
SURFACE ELEVATION 551.92

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	16	Topsoil Depth 2"		550	14 (7-7-7)
					Sandy SILT, Trace Gravel, Brown, Moist, Medium Dense, (ML-FILL)			12.1 29 39
	2	SS	18	18				8 (4-4-4)
5	3	SS	18	18	Sandy SILT, With Decomposed Rock, Reddish Brown, Moist, Firm to Medium Dense, (ML)		545	13 (4-6-7)
	4	SS	18	16	Sandy SILT and Decomposed Rock, Trace Rock Fragments, Reddish Brown, Moist, Very Dense (ML)			(15-25-28) 53
10							540	
	5	SS	5	5	Decomposed Rock and Rock Fragments, With Sandy Silt, Reddish Brown to Gray, Moist, Very Dense			(50/5) 50/5
15							535	
	6	SS	18	14				(12-27-33) 60
20							530	
	7	SS	4	4				(50/4) 50/4
25	8	SS	0	0			525	(50/0) 50/0
					AUGER REFUSAL @ 25.5'			
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR ▽WD	BORING STARTED 06-02-08	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 06-02-08	CAVE IN DEPTH ● 25.5'
▽WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AMEWIT (08-25-08) AMEWIT (08-29-08)
gradewell(08/15/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-10	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % (X) — WATER CONTENT % — LIQUID LIMIT % (Δ)

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 572.67

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	18	Topsoil Depth 2"		4 (1-2-2)
					Sandy SILT, Trace Gravel, Trace Roots, Brown, Moist, Loose, (ML-FILL)	570	
	2	SS	18	18			8 (2-3-5)
5	3	SS	18	18	Sandy SILT, With Decomposed Rock, Trace Rock Fragments, Brown to Reddish Brown, Moist, Firm to Medium Dense, (ML)	565	12 (4-5-7)
	4	SS	18	18	Sandy SILT and Decomposed Rock, With Rock Fragments, Reddish Brown, Moist, Medium Dense to Very Dense, (ML)		24 (7-11-13)
10						560	
	5	SS	18	16			(17-26-32) 58
15						555	
	6	SS	10	10	Decomposed Rock and Rock Fragments, With Sandy Silt, Grayish Brown, Moist, Very Dense		(35-50/4) 50/4
20						550	
	7	SS	3	3			(50/3) 50/3
25						545	
	8	SS	18	18	Sandy SILT, With Decomposed Rock and Rock Fragments, Tan, Moist, Medium Dense, (ML)		16 (7-7-9)
30							

CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 06-02-08	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 06-02-08	CAVE IN DEPTH ● 36.5'
▽WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AHDWITT (08-25-08) AHDWITT (06-26-08)

(8002/91/80)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-10	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.% ——
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 572.67

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
30						540
	9	SS	3	3		
35						
	10	SS	0	0		535
40						
						530
45						
						525
50						
						520
55						
						515
60						

Decomposed Rock and Rock Fragments, With Sandy Silt, Grayish Brown, Moist, Very Dense

AUGER REFUSAL @ 36.5'

(50/3) 50/3

(50/0) 50/0

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▼WL DRY WS OR WD	BORING STARTED	06-02-08	
▼WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED	06-02-08	CAVE IN DEPTH @ 36.5'
▼WL	RIG 550A	FOREMAN V.M.	DRILLING METHOD HSA

AGENCY (06-25-08) AMENDMENT (05-26-08)

graincent(06/18/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-11	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 554.89

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION
0	1	SS	18	18		9 (3-5-4)
						Topsoil Depth 3"
	2	SS	18	18		5 (2-3-2)
						Sandy SILT, Trace Clay, Trace Gravel, Trace Decomposed Rock, Brown, Moist, Firm, (ML-FILL)
5	3	SS	18	18	550	6 (3-3-3)
						Sandy SILT, With Decomposed Rock and Rock Fragments, Reddish Brown, Moist, Loose to Medium Dense, (ML)
	4	SS	18	18		14 (7-7-7)
10					545	
	5	SS	18	18		24 (9-12-12)
15					540	
	6	SS	18	18		19 (8-8-11)
20					535	
	7	SS	18	18		22 (8-8-14)
25					530	
						END OF BORING @ 25.0'
30						

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR ATD	BORING STARTED 06-04-08	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 06-04-08	CAVE IN DEPTH @ 21.0'
▽WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AMEWIT (06-25-08) AMEWIT (06-25-08)

grabowski(06/16/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	B-12	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 549.24

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	18	Topsoil Depth 2"		10 (3-4-6)
	2	SS	18	18	Sandy SILT, Trace Clay, Trace Gravel, Dark Brown, Moist, Firm to Medium Dense, (ML-FILL)	545	6 (3-3-3)
5	3	SS	18	18	Sandy CLAY, Trace Decomposed Rock, Reddish Brown, Moist, Soft, (CL)		4 (2-2-2)
10	4	SS	18	18	Sandy SILT, With Decomposed Rock and Rock Fragments, Reddish Brown, Moist, Medium Dense, (ML)	540	10 (4-6-4)
15	5	SS	18	14		535	14 (6-7-7)
20	6	SS	18	16		530	16 (6-7-9)
25	7	SS	18	16	Sandy SILT and Decomposed Rock, With Rock Fragments, Gray, Moist, Very Dense, (ML)	525	(20-31-26) 57
30					END OF BORING @ 25.0'	520	

Water levels: 19.3 ● at 545; 13.9 ● at 540; 8.7 ● at 535

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▼WL DRY	WS OR WD	BORING STARTED 06-04-08	
▼WL(BCR) DRY ▼WL(ACR) DRY		BORING COMPLETED 06-04-08	CAVE IN DEPTH @ 21.0'
▼WL		RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AHENTT (08-25-08) AHENTT (08-25-08)

grutkowski(08/14/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	P-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)

PLASTIC LIMIT % (X) — WATER CONTENT % (●) — LIQUID LIMIT % (Δ)

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (⊗)
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 572.33

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)	DESCRIPTION OF MATERIAL
0						Asphalt Depth 3"
	1	SS	18	16		Gravel Depth 4"
	2	SS	18	18	570	Sandy SILT, Trace Gravel, Trace Decomposed Rock, Brownish Gray, Moist, Firm to Medium Dense, (ML-FILL)
5	3	SS	18	18		Sandy SILT, Trace Clay, Trace Decomposed Rock, Reddish Brown, Moist, Medium Dense, (ML)
	4	SS	18	16	565	
10						END OF BORING @ 10.0'
15					560	
20					555	
25					550	
30					545	

⊗ 8 (5-4-4)
⊗ 21 (4-8-13)
⊗ 14 (5-7-7)
⊗ 26 (11-13-13)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY	WS OR WD	BORING STARTED 06-04-08	
▽WL(BCR) DRY ▽WL(ACR) DRY		BORING COMPLETED 06-04-08	CAVE IN DEPTH @ 7.0'
▽WL	RIG 550A	FOREMAN V.M.	DRILLING METHOD HSA

AMERITT (08-25-08) AMERITT (06-06-08)
gpjdotmod(08/18/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	P-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 6+)

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 579.49

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Asphalt Depth 4"		
	1	SS	18	18	Gravel Depth 4"		14 (8-6-8)
	2	SS	18	18	Sandy SILT, With Decomposed Rock, Trace Rock Fragments, Reddish Brown, Moist, Medium Dense, (ML)		11 (5-5-6)
5	3	SS	18	18		575	12 (7-5-7)
	4	SS	18	16	Decomposed Rock and Rock Fragments, With Sandy Silt, Light Grayish Brown, Moist, Very Dense	570	(26-40-50/6) 50/6
10					END OF BORING @ 10.0'		
15						565	
20						560	
25						555	
30						550	

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 06-04-08	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 06-04-08	CAVE IN DEPTH @ 7.0'
▽WL	RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

ANEWITT (08-25-08) ANEWITT (06-26-08)

gratboreA(08/15/2008)

CLIENT	JOB #	BORING #	SHEET
THE LUKEMIRE PARTNERSHIP	13-3361	P-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
MONTGOMERY COLLEGE BIOSCIENCE CENTER	

ECS LLC MID-ATLANTIC

SITE LOCATION
OBSERVATION DRIVE, GERMANTOWN, MARYLAND

MONTGOMERY COUNTY

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION (100%)

SURFACE ELEVATION 558.79

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	18	16	Topsoil Depth 4"		4 (1-2-2)
					Sandy SILT, Trace Clay, Trace Decomposed Rock and Rock Fragments, Reddish Brown, Moist, Loose, (ML)		
	2	SS	18	18		555	4 (3-2-2)
5	3	SS	18	18	Sandy SILT, With Decomposed Rock and Rock Fragments, Trace Clay, Reddish Brown, Moist, Medium Dense, (ML)		11 (4-5-6)
	4	SS	18	18		550	17 (5-8-9)
10					END OF BORING @ 10.0'		
15						545	
20						540	
25						535	
30						530	

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY	WS OR WD	BORING STARTED 06-04-08	
▽WL(BCR) DRY ▽WL(ACR) DRY		BORING COMPLETED 06-04-08	CAVE IN DEPTH ● 6.5'
▽WL		RIG 550A FOREMAN V.M.	DRILLING METHOD HSA

AMEC WITT (06-25-08) AMEWITT (06-26-08)

grotkowski(06/16/2008)

SOIL CLASSIFICATION LEGEND

- FILL - FILL (POSS/PRTD) OF ALL TYPES.
- GW - WELL GRADED GRAVEL
- GM - SILTY GRAVEL
- GP - POORLY GRADED GRAVEL
- GC - CLAYEY GRAVEL
- SW - WELL GRADED SAND
- SM - SILTY SAND
- SP - POORLY GRADED SAND
- SC - CLAYEY SAND
- ML - LOW PLASTICITY SILT
- CL - LOW PLASTICITY CLAY
- MH - HIGH PLASTICITY SILT
- CH - HIGH PLASTICITY CLAY
- OH - HIGH PLASTICITY ORGANIC SILTS AND CLAYS
- OL - LOW PLASTICITY ORGANIC SILTS AND CLAY
- PT - PEAT

SURFACE MATERIALS

- TOPSOIL
- ASPHALT
- GRAVEL
- CONCRETE
- VOID

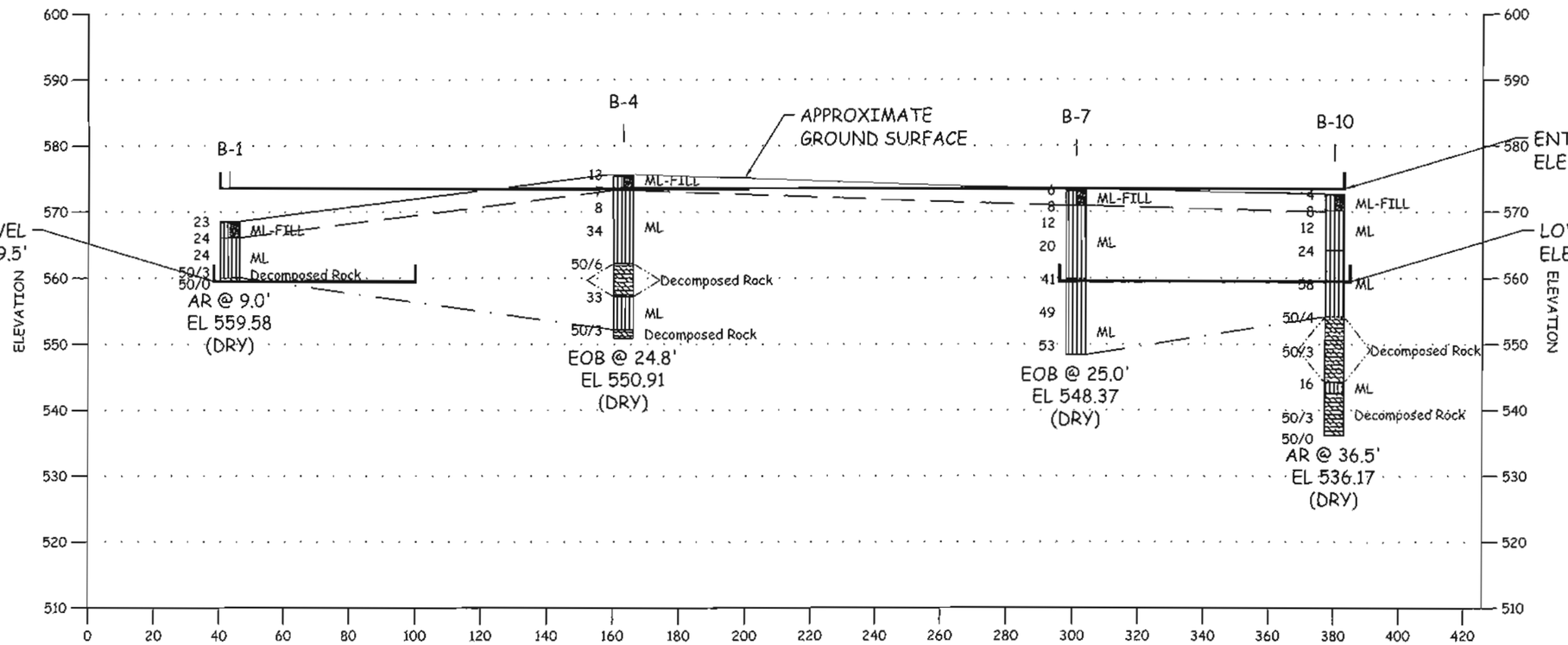
ROCK TYPES

- IGNEOUS
- METAMORPHIC
- SEDIMENTARY

SYMBOL LEGEND

- WATER LEVEL SYMBOL
- WATER LEVEL - BEFORE CASING REMOVAL
- WATER LEVEL - AFTER CASING REMOVAL
- WATER LEVEL - AFTER 24 HOURS

SECTION A-A'



SCALE
VERTICAL SCALE 1"=20'
HORIZONTAL SCALE 1"=40'

MONTGOMERY COLLEGE
BIOSCIENCE CENTER
MONTGOMERY COUNTY

ECS LLC MID-ATLANTIC

CROSS SECTION DIAGRAMS
THE LUKEMIRE PARTNERSHIP

ECS REVISIONS

ENGINEER	DRAFTING
GAR	AMH

SCALE: AS SHOWN
PROJECT NO.: 13-3361
SHEET: 1 OF 2
DATE: 06-25-08

SOIL CLASSIFICATION LEGEND

- FILL - FILL (POSS/PROB OF ALL TYPES.
- GW - WELL GRADED GRAVEL
- GM - SILTY GRAVEL
- GP - POORLY GRADED GRAVEL
- GC - CLAYEY GRAVEL
- SW - WELL GRADED SAND
- SM - SILTY SAND
- SP - POORLY GRADED SAND
- SC - CLAYEY SAND
- ML - LOW PLASTICITY SILT
- CL - LOW PLASTICITY CLAY
- MH - HIGH PLASTICITY SILT
- CH - HIGH PLASTICITY CLAY
- OH - HIGH PLASTICITY ORGANIC SILTS AND CLAYS
- OL - LOW PLASTICITY ORGANIC SILTS AND CLAY
- PT - PEAT

SURFACE MATERIALS

- TOPSOIL
- ASPHALT
- GRAVEL
- CONCRETE
- VOID

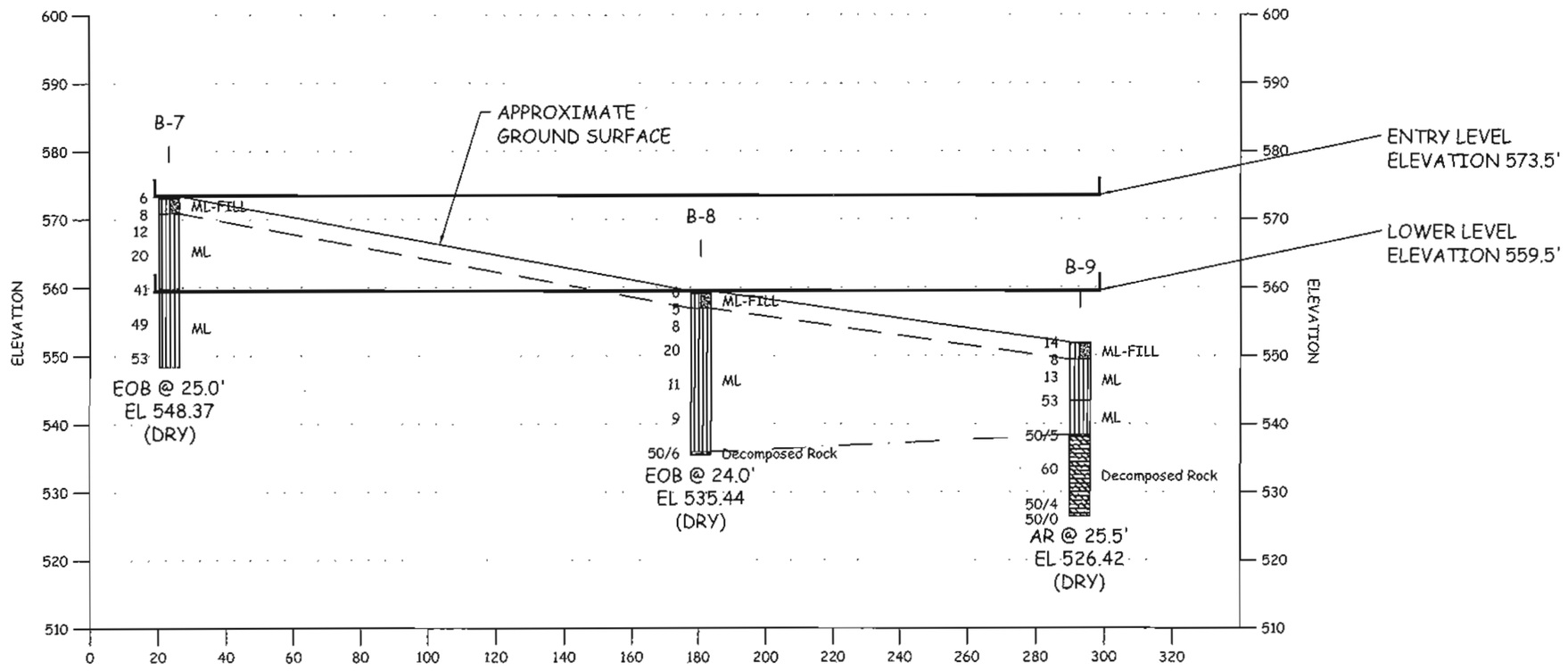
ROCK TYPES

- IGNEOUS
- METAMORPHIC
- SEDIMENTARY

SYMBOL LEGEND

- WATER LEVEL SYMBOL
- WATER LEVEL - BEFORE CASING REMOVAL
- WATER LEVEL - AFTER CASING REMOVAL
- WATER LEVEL - AFTER 24 HOURS

SECTION B-B'



SCALE
VERTICAL SCALE 1"=20'
HORIZONTAL SCALE 1"=40'

MONTGOMERY COLLEGE
BIOSCIENCE CENTER
MONTGOMERY COUNTY

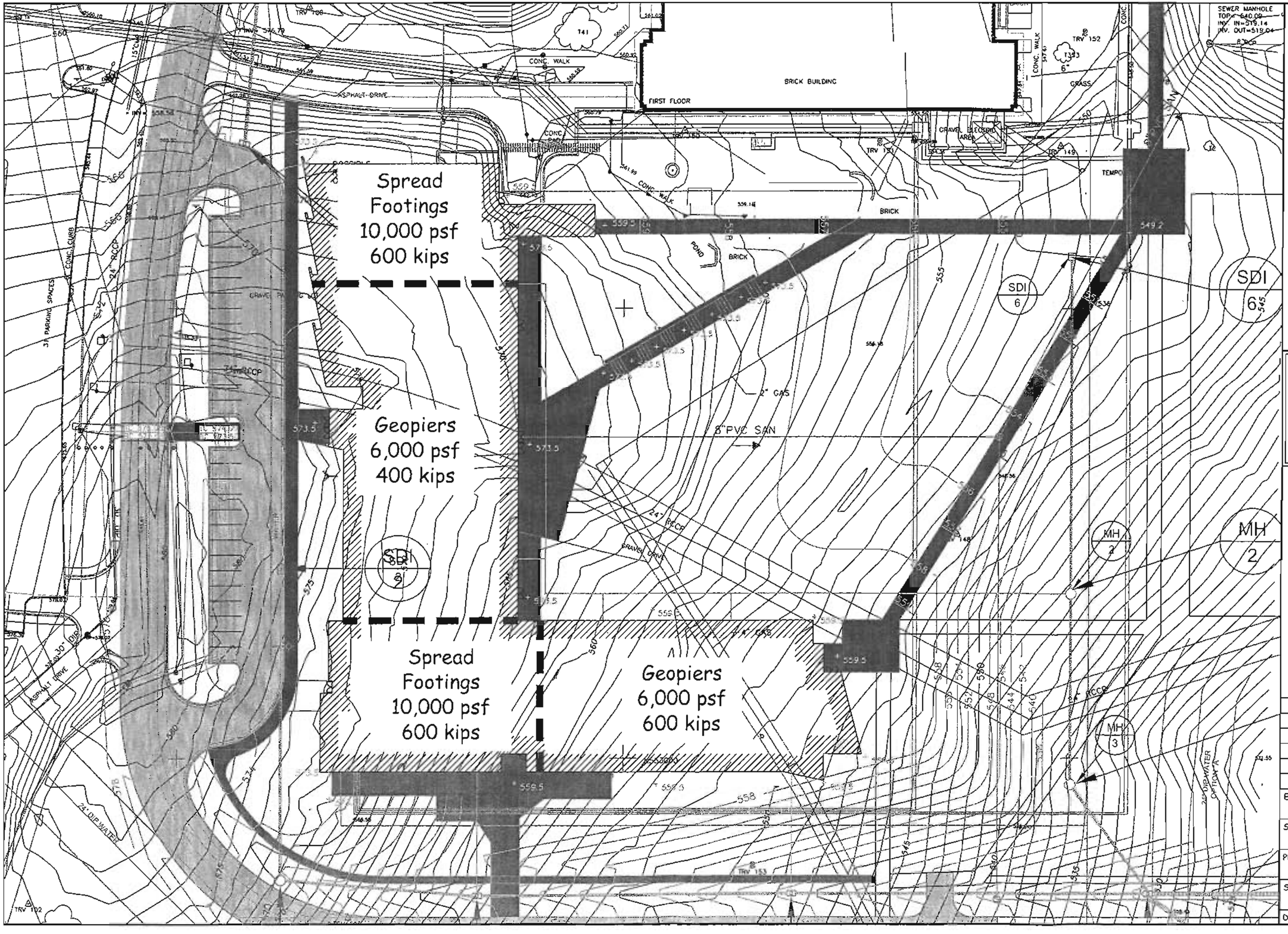
ECS LLC MID-ATLANTIC

CROSS SECTION DIAGRAMS
THE LUKEMIRE PARTNERSHIP

ECS REVISIONS

ENGINEER	DRAFTING
GAR	AMH

SCALE: AS SHOWN
PROJECT NO.: 13-3361
SHEET: 2 OF 2
DATE: 06-25-08



MONTGOMERY COLLEGE
BIOSCIENCE CENTER
MONTGOMERY COUNTY

ECS LLC MID-ATLANTIC

FOUNDATION TYPE LOCATION DIAGRAM
THE LUKMIRE PARTNERSHIP

ECS REVISIONS

ENGINEER	DRAFTING
GAR	AMH

SCALE	1"=50'
PROJECT NO.	13-3361
SHEET	1 OF 1
DATE	06-19-08

MONTGOMERY COLLEGE
BIOSCIENCE CENTER
MONTGOMERY COUNTY

ECS LLC MID-ATLANTIC

BORING & CROSS SECTION LOCATION DIAGRAM

THE LUKMIRE PARTNERSHIP

ECS REVISIONS

ENGINEER	DRAFTING
GAR	AMH

SCALE	1"=60'
PROJECT NO.	13-3361
SHEET	1 OF 1
DATE	06-19-08

LEGEND

APPROX. BORING LOCATION

March 29, 2010

Mr. Greg Lukmire
The Lumkire Partnership
2700 South Quincy Street
Suite 300
Arlington, VA 22206

ECS Job No.: 13-3921

Reference: Results of Subsurface Exploration and Geotechnical Engineering Analysis, Montgomery College Bioscience Center SWM, WSSC, and Roadway Borings, Observation Drive, Germantown, Maryland

Dear Mr. Lukmire:

As requested, ECS Mid-Atlantic, LLC (ECS) has completed the soil borings for the proposed stormwater management facilities and the proposed roadway expansion at the referenced project. Our report includes the results of our soil borings and a boring location diagram.

We understand that Observation Drive will be extended northward from its intersection with Middlebrook Road. New paved parking and driveways are proposed around the new building. A WSSC water line will be extended along the south side of the new building. Several stormwater management facilities and ponds are also proposed.

EXPLORATION PROCEDURES

Subsurface Exploration Procedures

The soil borings were performed using all-terrain vehicle (ATV) mounted auger drilling rigs (CME 750), which utilized continuous flight, hollow stem augers to advance the boreholes. Drilling fluid was not used in this process.

Representative soil samples were obtained by means of the split-spoon sampling procedure in accordance with ASTM Specification D-1586. In this procedure, a 2-inch O.D., split-spoon sampler is driven into the soil a distance of 18 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through the last 12-inch interval is termed the Standard Penetration Test (SPT) value, or N value, and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of non-cohesive soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

A field log of the soils encountered in the borings was maintained by the drill crew. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample were then sealed and brought to our laboratory for further visual examination and laboratory testing.

Soil samples recovered from the soil borings will be retained in our soil laboratory for a period of 60 days after which they will be discarded unless other instructions are received as to their disposition.

EXPLORATION RESULTS

Soil Conditions

Subsurface conditions within the proposed site were evaluated with forty-nine (49) soil test borings extended to depths of 10 to 30 feet below the existing ground surface. Nine borings (ROAD -1 to ROAD-9) were drilled along the proposed Observation Drive alignment. Thirty borings were drilled at the proposed stormwater management locations. Ten borings were drilled along the proposed WSSC utility alignments (WSSC-1 to WSSC-10). The approximate boring locations are presented on the enclosed Boring Location Diagram.

Approximately 2 to 7 inches of topsoil were encountered at the boring locations. Existing fill material was encountered beneath the topsoil layer at boring locations ROAD-9, WSSC-1, WSSC-3, WSSC-4, WSSC-5, and WSSC-9, and extended to depths of approximately 3 to 10 feet below existing grades. The fill material consisted primarily of SILT (ML-FILL), Clayey SILT (ML-FILL), and Silty CLAY (CL-FILL).

Natural soils were encountered below the existing fill, where encountered, or below the topsoil layer. The natural soils were identified as Silty SAND (SM), Sandy SILT (ML), SILT (ML), Clayey SILT (ML), and CLAY (CL). Based on Standard Penetration Test (SPT) results, the density of the natural soils encountered are generally firm to very dense. Some loose or soft soils were encountered near the surface at some of the boring locations. The color of the natural materials ranged from brown to reddish brown and orangish brown. The moisture content of these soils was generally characterized as moist to wet.

Below the natural soils and interbedded with the natural soils in borings ROAD-1, SWMA-2, SWMA-3, SWMA-6, SWMB-1, SWMB-2, SWME-5, SWME-8 through SWME-11, WSSC-1, and WSSC-6, very dense material with a blow count greater than 60 has been noted on the boring logs as decomposed rock. Decomposed rock materials were encountered in these borings at depths of 8.5 feet to 23.5 feet below existing grades. These materials exhibit rock like qualities and depending on various parameters may be extremely difficult to excavate.

More detailed descriptions of the soils encountered are provided on the boring logs attached to this letter.

Groundwater Observations

Groundwater was during drilling in soil borings SWMA-1 through SWMA-4 at depths ranging from 9.25 feet to 15.75 feet below the ground surface, or elevation EL 400.28 to EL 412.91. All other borings were observed to be dry. Observations for groundwater were made during sampling and upon completion of the drilling operations at each boring location. In auger drilling operations, water is not introduced into the boreholes, and the groundwater position can often be determined by observing water flowing into or out of the boreholes. Furthermore, visual observation of the soil samples retrieved during the auger drilling exploration can often be used in evaluating the groundwater conditions. Cave in depths ranged from 5.0 feet to 20.25 feet at the boring locations.

The highest groundwater observations are normally encountered in winter and early spring. Variations in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, and other factors not immediately apparent at the time of this exploration. Free water may also be encountered at the interface of fine-grained and coarse-grained soils, or at the interface of the soil and decomposed rock or bedrock.

Laboratory Testing Program

Representative soil samples were selected and tested in our laboratory to confirm the field classifications and to determine pertinent engineering properties for evaluating the suitability of the on-site soils for support of new fills, pavements, and SWM structures. The laboratory testing program included moisture content tests, Atterberg Limits, washed sieve gradation tests, standard proctor tests, and California Bearing Ratios (CBR). Data obtained from the laboratory tests are included in the Appendix, and are summarized in the table below:

Boring No. (Depth)	Soil Description	Liquid Limit	Plasticity Index	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	CBR 1 Value (0.1"/0.2")	CBR 2 Value (0.1"/0.2")
ROAD-1 (8')	Brown Silty SAND w/ Gravel (SM)	34	NP	121.1	11.7	13.2	15.4
ROAD-4 (1')	Orangish Brown Sandy SILT (ML)	40	12	111.6	16.1	N/A	N/A
ROAD-5 (5')	Reddish Brown Sandy SILT (ML)	48	15	108.1	18.3	6.3	7.6
ROAD-7 (3')	Brown Silty SAND (SM)	39	10	108.8	18.0	7.4	9.0
SWMA-2 (10')	Brown Sandy SILT (ML)	38	9	113.2	15.8	N/A	N/A
SWMA-3 (10')	Reddish Brown Sandy SILT (ML)	47	18	115.2	16.8	N/A	N/A
SWME-8 (4')	Reddish Brown Silty SAND (SM)	38	9	114.7	14.2	N/A	N/A
WSSC-1 (5')	Reddish Brown Sandy SILT (ML)	40	9	N/A	N/A	N/A	N/A
WSSC-5 (5')	Reddish Brown Sandy SILT (ML)	41	12	N/A	N/A	N/A	N/A
WSSC-6 (5')	Reddish Brown Sandy SILT (ML)	43	13	106.6	18.5	N/A	N/A
WSSC-9 (2')	Reddish Brown Sandy SILT (ML)	39	11	N/A	N/A	N/A	N/A

PAVEMENT RECOMMENDATIONS – PARKING LOT

All pavement subgrades should be prepared in accordance with the recommendations in the section entitled "**Fill and Pavement Subgrades**" included in this letter.

ECS conducted a pavement analysis for the asphalt parking area and has developed a recommended pavement section. This pavement section does not apply to the proposed extension of Observation Drive. Our pavement section is based on a traffic volume of 20,000 ESALS. The traffic load is based upon 2500 cars and light trucks per day. If the expected traffic volume will be different than the volume stated herein, we must be notified so that our pavement recommendations can be updated as necessary.

We anticipate that natural silty and sandy soils or new compacted structural fill may be expected at pavement subgrades. These soils are expected to provide fair to good pavement support. For design of pavements, we have utilized a CBR value of 5 for the on-site silty and sandy soils and new compacted fill, which is based on results of laboratory testing as well as experience with similar projects.

Our pavement analyses are based on methodology from the American Association of State Highway and Transportation Officials' (AASHTO) Guide of Design of Pavement Structures, 1993. Summarized below are the subgrade strength parameters, the traffic conditions, and other design parameters and criteria considered in these analyses.

CBR Value / Resilient Modulus:	5/7500 psi
Traffic Load Design:	20,000 ESALS
Reliability:	75 percent
Overall Variance:	0.45
Initial Serviceability:	4.0
Terminal Serviceability:	2.0

Using the above-indicated design parameters, we recommend the following pavement section:

Pavement Material	Pavement Section (Inches)
Surface Course Asphalt (9.5 mm Superpave)	2.0
Base Course Asphalt (19 mm Superpave)	2.0
Compacted Crushed Stone Base (CR-6)	6.0
Total Pavement Thickness	10.0

An important consideration in the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the base course layer, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Furthermore, good drainage should minimize the possibility of the subgrade materials becoming saturated over a long period of time. Since the compacted subgrade soils will tend to minimize the downward migration of surface water, it is imperative that the subgrade soils in the paved areas be graded to facilitate surface drainage and provisions be made to remove any free water from the granular subbase beneath the asphalt surface. The pavement section given above assumes a good drainage condition.

Immediately prior to pavement construction, the exposed subsoils throughout the proposed paved areas must be carefully and thoroughly proofrolled/compacted and visually examined in order to detect any yielding, soft or otherwise unsuitable soil conditions; particularly, in any previously disturbed areas such along utility lines and in areas subjected to construction traffic. In the event that any unstable conditions occur, the distressed asphalt should be removed and yielding and soft areas must be undercut and returned to subgrade level with approved compacted fill or crushed stone. All proofrolling should be accomplished with approved equipment and must be monitored by the Geotechnical Engineer or his authorized representative. Placement of the granular subbase and the rigid pavement section should occur immediately after the subbase soils have been evaluated and determined suitable for pavement construction by the Geotechnical Engineer or his authorized representative.

Fill and Pavement Subgrades

Prior to fill placement, the subgrade soils should be carefully examined by an experienced Geotechnical Engineer or authorized representative to identify any localized loose, yielding or otherwise unsuitable materials. After examining the exposed soils, loose and yielding areas should be identified by proofrolling with an approved piece of equipment, such as a loaded dump truck, having an axle weight of at least 10 tons. Any soft or unsuitable materials encountered during this proofrolling should be removed and replaced with an approved engineered fill compacted, or recompacted, to the criteria provided below**.**

Upon achieving competent subgrade materials, after the removal of the topsoil and any unsuitable soils, compacted structural fill should be placed to subgrade levels with an approved, controlled, compacted engineered fill. Engineered fill below the top 12 inches of subgrade level should consist of soils classified ML, SM, or more granular per ASTM D-2487, with a liquid limit and plasticity index of less than 40 and 15, respectively, and compacted to at least 95 percent of the maximum dry density per AASHTO T99 Method C. Fill in the top 12 inches below roadway subgrade levels should be classified as ML or more granular with a liquid limit and plasticity index of less than 40 and 12, respectively, and a maximum dry density of at least 105 pcf. The top 12 inches shall be compacted to at least 100 percent of the maximum dry density per AASHTO T99 Method C. All structural fill should be placed in loose lifts, which do not exceed 8 inches in thickness. Generally, the moisture content of the fill materials should be maintained within ± 2 percent of the optimum moisture content for the fill material, as determined by AASHTO T-99.

An examination of the soil boring data and the lab testing results indicates that most of the on site sandy silt and silty sand soils will be suitable for reuse as controlled, compacted fill, below the pavements. Prior to the utilization of any off-site borrow materials, the Geotechnical Engineer should be provided with representative samples in order to determine the material suitability for use as a controlled, compacted fill and to develop moisture-density relationships. In order to expedite the earthwork operations, if off-site borrow materials are required, it is recommended that those material consist of a granular material which will provide suitable support, and be easily compacted and well drained.

Grade controls should be maintained throughout the filling operations. All filling operations should be observed on a full-time basis by a qualified soils technician to determine that minimum compaction requirements are being achieved. A minimum of one compaction test per 2,500 square foot area should be made for each lift. The elevation and location of the tests should be clearly identified at the time of fill placement.

Compaction equipment suitable to the soil type used as fill should be selected to compact the fill. Theoretically, any equipment type can be used as long as the required density is achieved. Ideally, a steel drum roller would be most efficient for compacting and sealing the surface soils. However, for fine-grained soils a sheepsfoot roller is recommended. All areas receiving fill should be graded to facilitate positive drainage away from the roadways of any free water associated with precipitation and surface run-off.

Fill materials should not be placed on frozen soils or frost-heaved soils and/or soils which have been recently subjected to precipitation. All frozen soils should be removed prior to continuation of fill operations. Borrow fill materials, if required, should not contain frozen materials at the time of placement.

If any problems are encountered during the earthwork operations, or if site conditions deviate from those encountered during our subsurface exploration, the Geotechnical Engineer should be notified immediately.

Closing

This report has been prepared to aid in the evaluation of this site and to assist the design team with the design of the proposed pavements and SWM facilities. The report scope is limited to this specific project and the location described. The project description represents our current understanding of the significant aspects of the proposed improvements relevant to the geotechnical considerations.

We appreciate the opportunity to have provided geotechnical engineering services on this project. Should you have questions regarding our findings or need additional consultations, please do not hesitate to contact our office.

Respectfully,

ECS MID-ATLANTIC, LLC

Gregory A. Ratkowski
Project Engineer

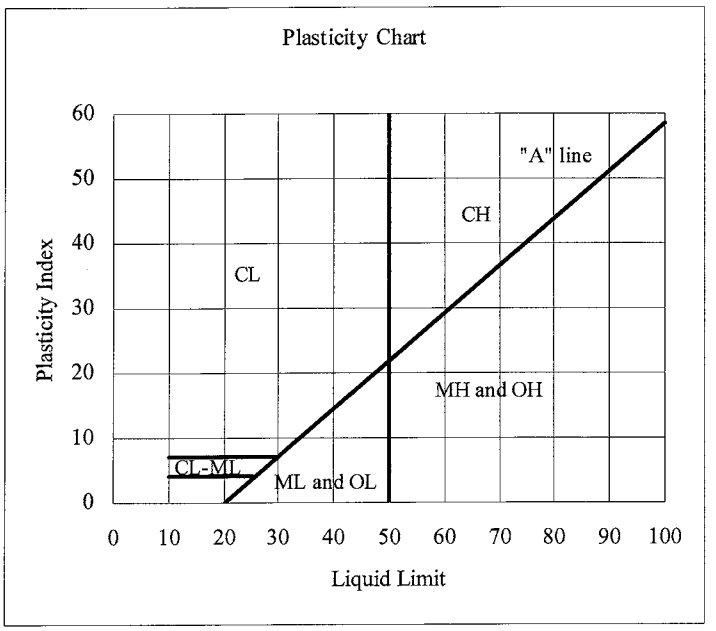
Jeffrey A. McGregor, P.E.
Geotechnical Manager

Attachments:

- United Soil Classification System (1 page)
- Laboratory Test Results (22 pages)
- Reference Notes for Boring Logs (1 page)
- Boring Logs (49 pages)
- Boring Location Diagram (1 page)

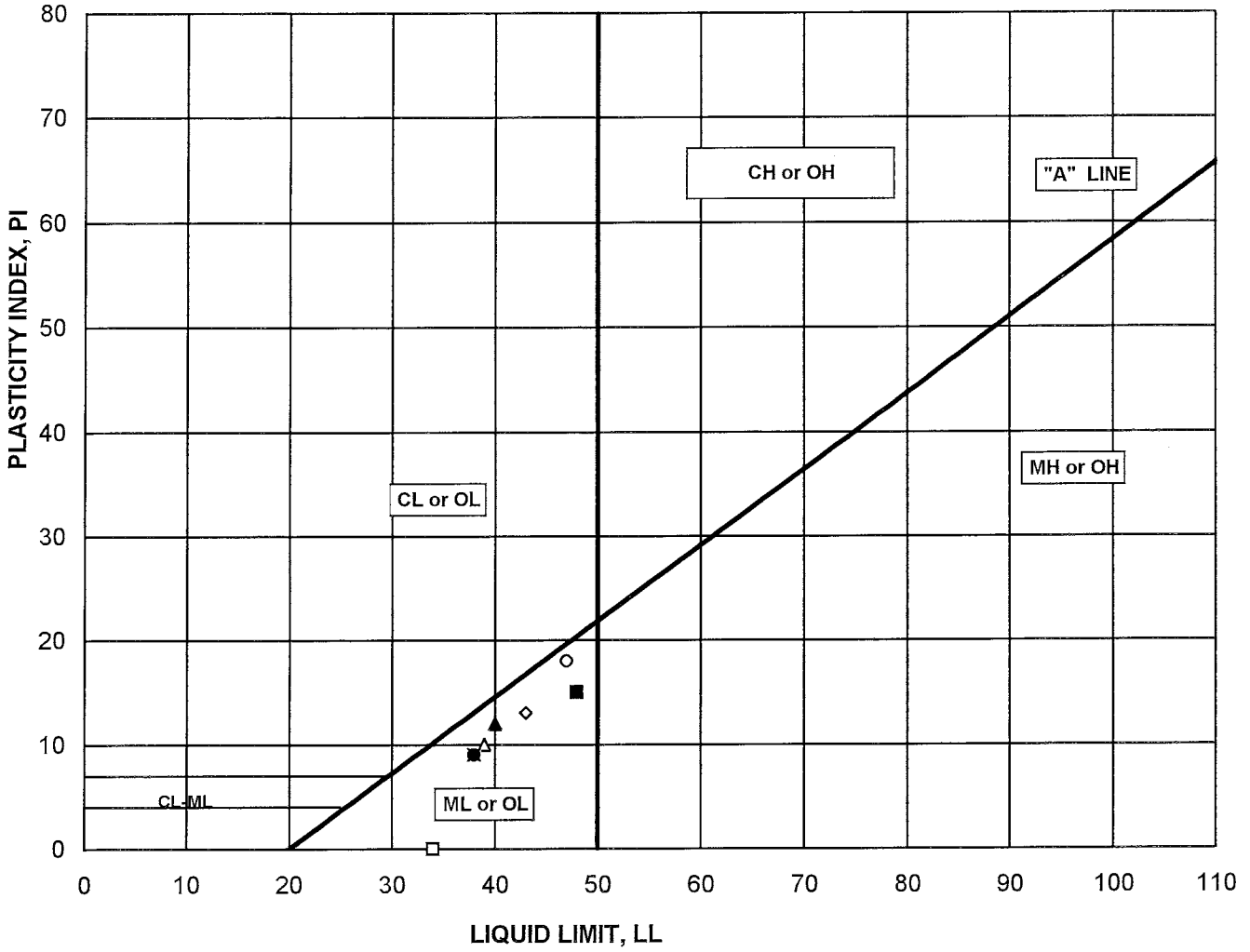
UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = D_{60}/D_{10}$ greater than 4 $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3		
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW		
		Gravels with fines (Appreciable amount of fines)	GM[a]	d u	Silty gravels, gravel-sand mixtures	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols	
			GC		Clayey gravels, gravel-sand-clay mixtures	Atterberg limits below "A" line or P.I. less than 7		
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_u = D_{60}/D_{10}$ greater than 6 $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3		
			SP		Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW		
		Sands with fines (Appreciable amount of fines)	SM[a]	d u	Silty sands, sand-silt mixtures	Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols	
			SC		Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7		
Fine-grained soils (More than half material is smaller than No. 200 Sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols[b]		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt		Peat and other highly organic soils			



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC,well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)



BORING/ SAMPLE No.	DEPTH (feet)	TEST SYMBOL	DESCRIPTION	WATER CONTENT (%)	LL	PL	PI
ROAD-1 / BAG		□	BROWN SILTY SAND W/GRAVEL (SM)		34	NP	NP
ROAD-5 / BAG	_	■	REDDISH BROWN SANDY SILT (ML)		48	33	15
ROAD-7 / BAG	_	△	BROWN SILTY SAND (SM)		39	29	10
ROAD-4 / BAG		▲	ORANGISH BROWN SANDY SILT (ML)		40	28	12
SWM-E8 / BAG		X	REDDISH BROWN SILTY SAND (SM)		38	29	9
SWM-A3 / BAG		○	REDISH BROWN SANDY SILT (ML)		47	29	18
SWM-A2 / BAG		●	BROWN SANDY SILT (ML)		38	29	9
WSSC-6 / BAG		◇	REDDISH BROWN SNADY SILT (ML)		43	30	13
/		◆			-	-	-
/		+			-	-	-
		X					

Applicable ASTM: D-4318

Project: MC BIOSCIENCE

Project No.: 3921

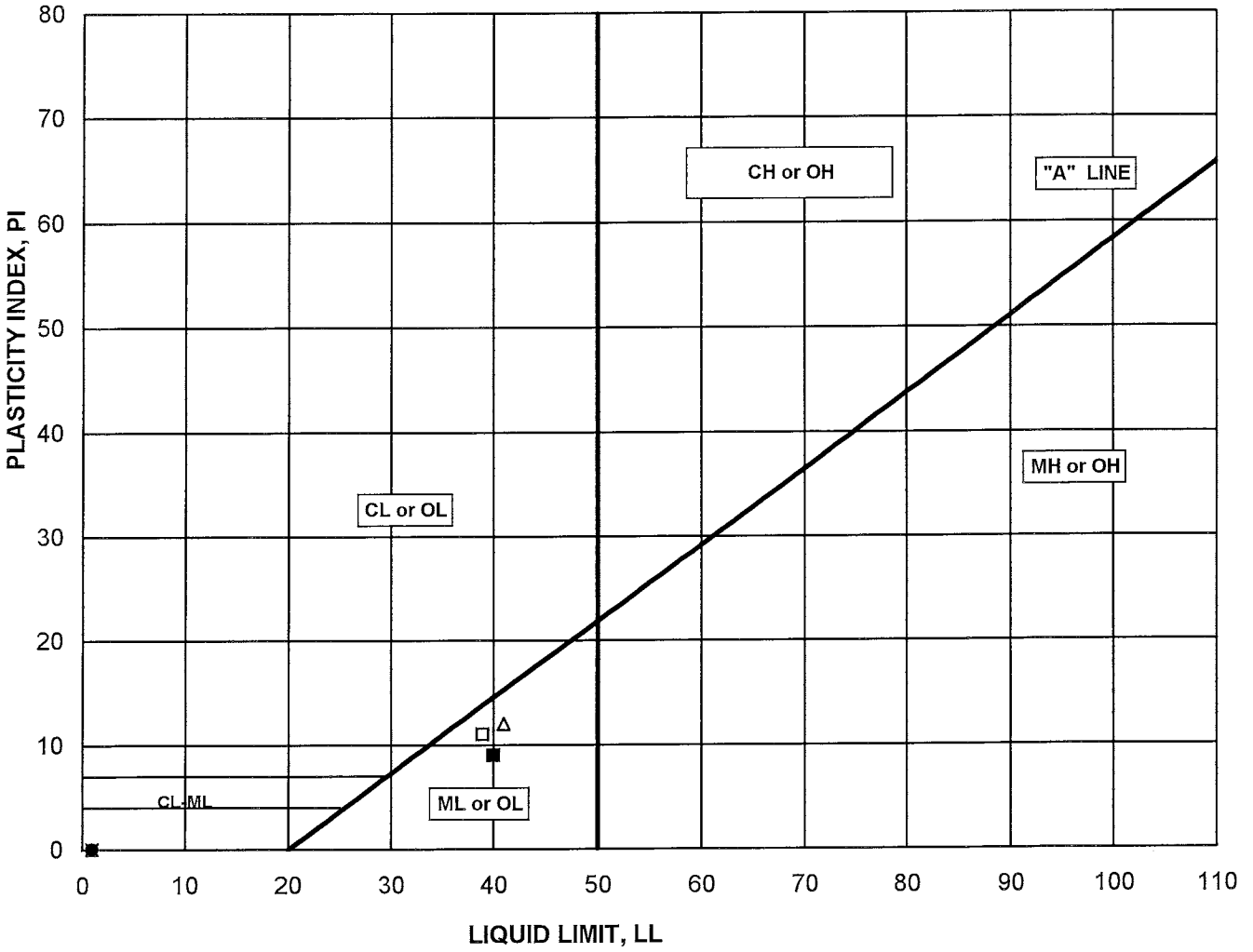
Date: 1/18/10

ECS - MID ATLANTIC LLC

Frederick, Maryland

Plasticity Chart

ROAD-1; SWM-C1; ROAD-5; ROAD-7; ROAD-9; SWM-A2; SWM-B1; SWM-E6; ROAD-6; SWM-E9; SWM-F1 MLIM



BORING/ SAMPLE No.	DEPTH (feet)	TEST SYMBOL	DESCRIPTION	WATER CONTENT (%)	LL	PL	PI
WSSC-9 / BAG		□	REDDISH BROWN SANDY SILT (ML)		39	28	11
WSSC-1 / BAG	_	■	REDDISH BROWN SANDY SILT (ML)		40	31	9
WSSC-5 / BAG	_	△	REDDISH BROWN SANDY SILT (ML)		41	29	12
/		▲			-	-	-
/		X			-	-	-
/		○			-	-	-
/		●			-	-	-
/		◇			-	-	-
/		◆			-	-	-
/		+			-	-	-
		X					

Applicable ASTM: D-4318

Project: MC BIOSCIENCE

Project No.: 3921

Date: 1/18/10

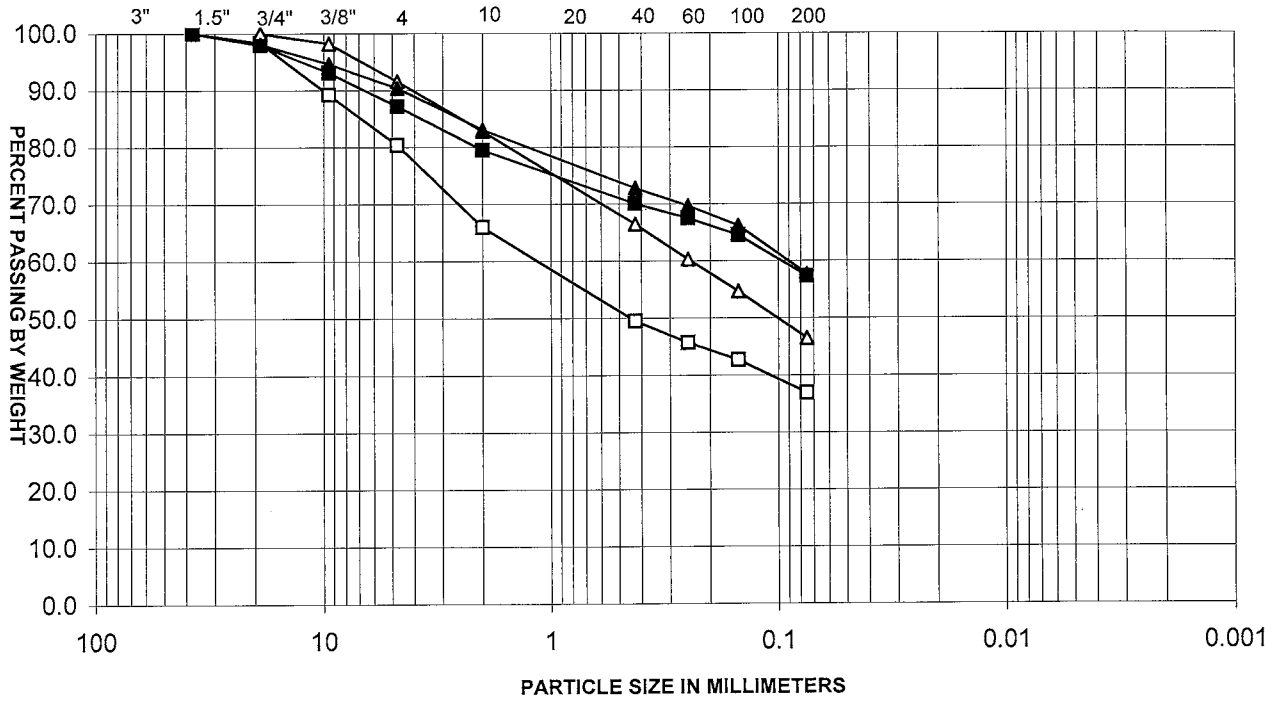
ECS - MID ATLANTIC LLC

Frederick, Maryland

Plasticity Chart

COBBL	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

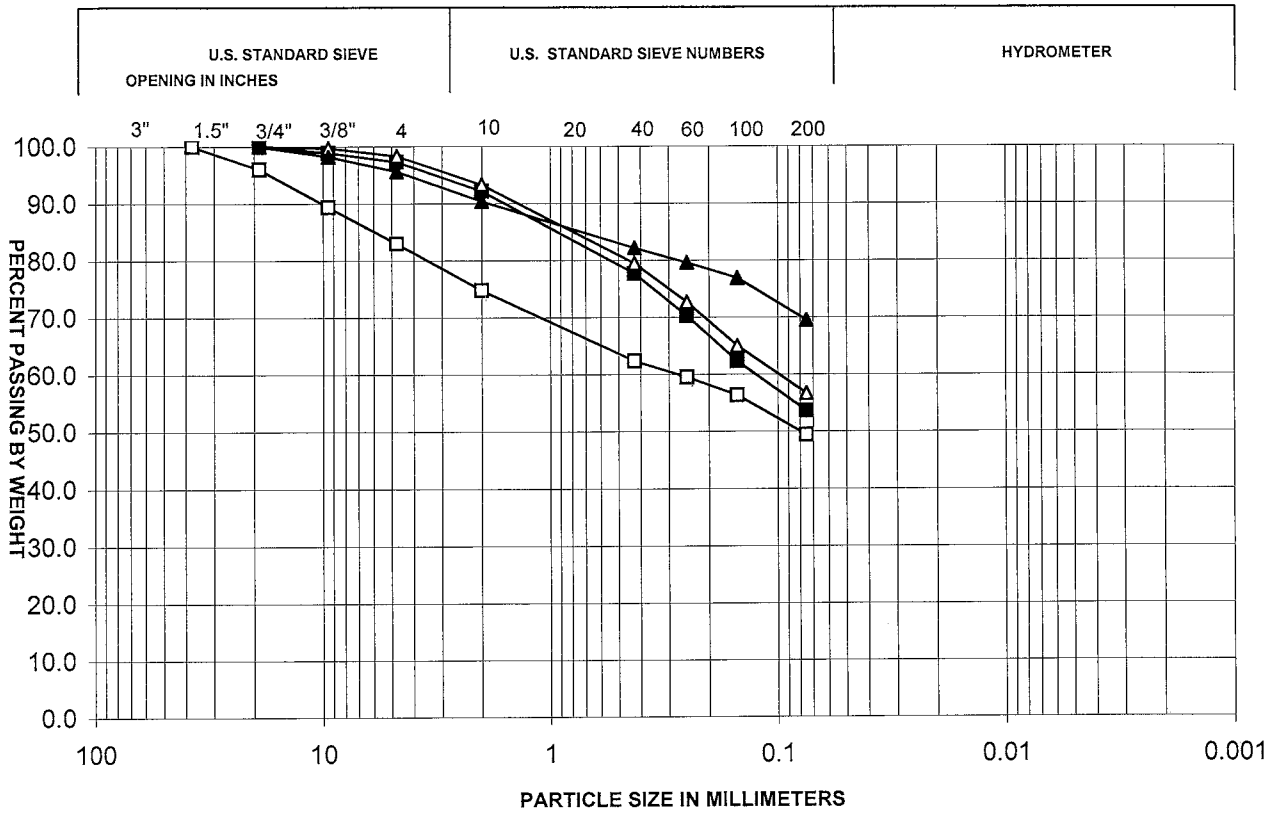
U.S. STANDARD SIEVE OPENING IN INCHES	U.S. STANDARD SIEVE NUMBERS	HYDROMETER



Boring/ Sample No.	Depth (feet)	Symbol	LL	PI	Description
ROAD-1 / BAG		□	34	NP	BROWN SILTY SAND W/GRAVEL (SM)
RTOAD-5 / BAG		■	48	15	REDDISH BROWN SANDY SILT (ML)
ROAD-7 / BAG		△	39	10	BROWN SILTY SAND (SM)
ROAD-4 / BAG		▲	40	12	ORANGISH BROWN SANDY SILT (ML)

Project: MC BIOSCIENCE Project No.: 3921 Date: 01/18/10	ECS - Mid-Atlantic, LLC Frederick, Maryland Grain Size Analysis

COBBL	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

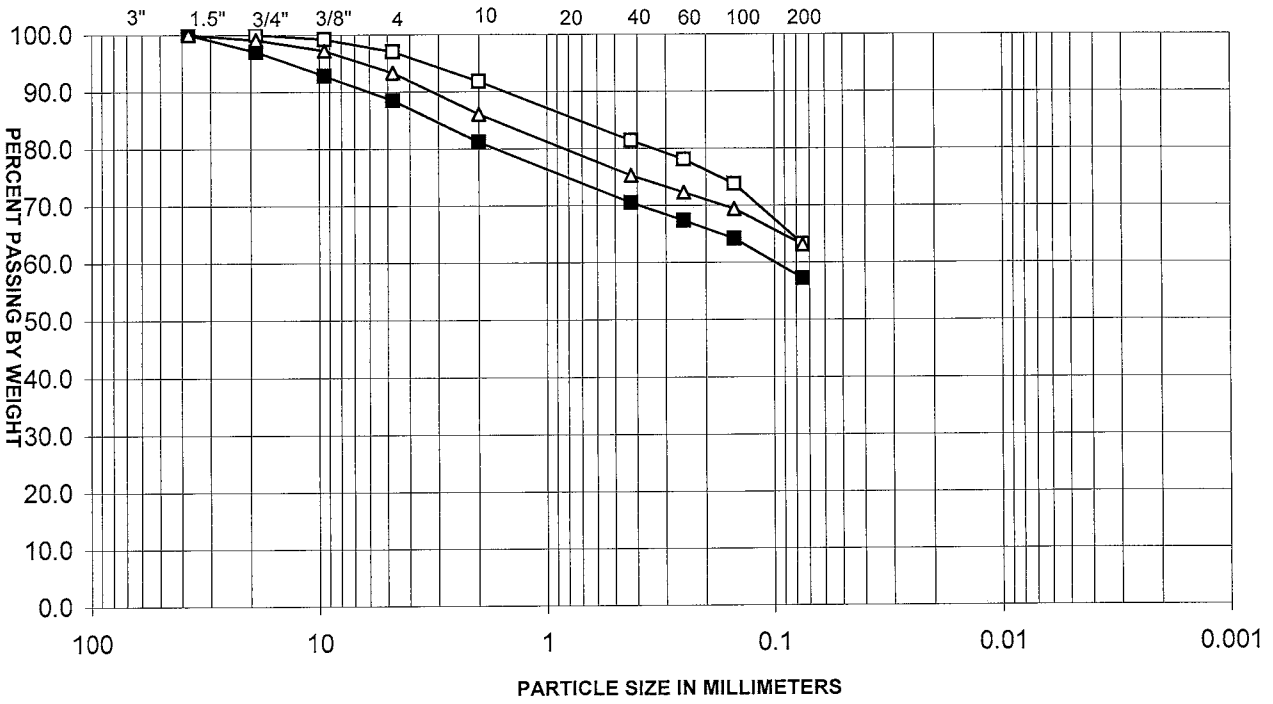


Boring/ Sample No.	Depth (feet)	Symbol	LL	PI	Description
SWM-E8 / BAG		□	38	9	REDDISH BROWN SILTY SAND (SM)
SWM-A3 / BAG		■	47	18	REDDISH BROWN SANDY SILT (ML)
SWM-A2 / BAG		△	38	9	BROWN SANDY SILT (ML)
WSSC-6 / BAG		▲	43	13	REDDISH BROWN SANDY SILT (ML)

Project: MC BIOSCIENCE Project No.: 3921 Date: 01/18/10	ECS - Mid-Atlantic, LLC Frederick, Maryland Grain Size Analysis

COBBL	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S. STANDARD SIEVE OPENING IN INCHES	U.S. STANDARD SIEVE NUMBERS	HYDROMETER



Boring/ Sample No.	Depth (feet)	Symbol	LL	PI	Description
WSSC-9 / BAG		□	39	11	REDDISH BROWN SANDY SILT (ML)
WSSC-1 / BAG		■	40	9	REDDISH BROWN SANDY SILT (ML)
WSSC-5 / BAG		△	41	12	REDDISH BROWN SANDY SILT (ML)
/		▲			

Project: MC BIOSCIENCE

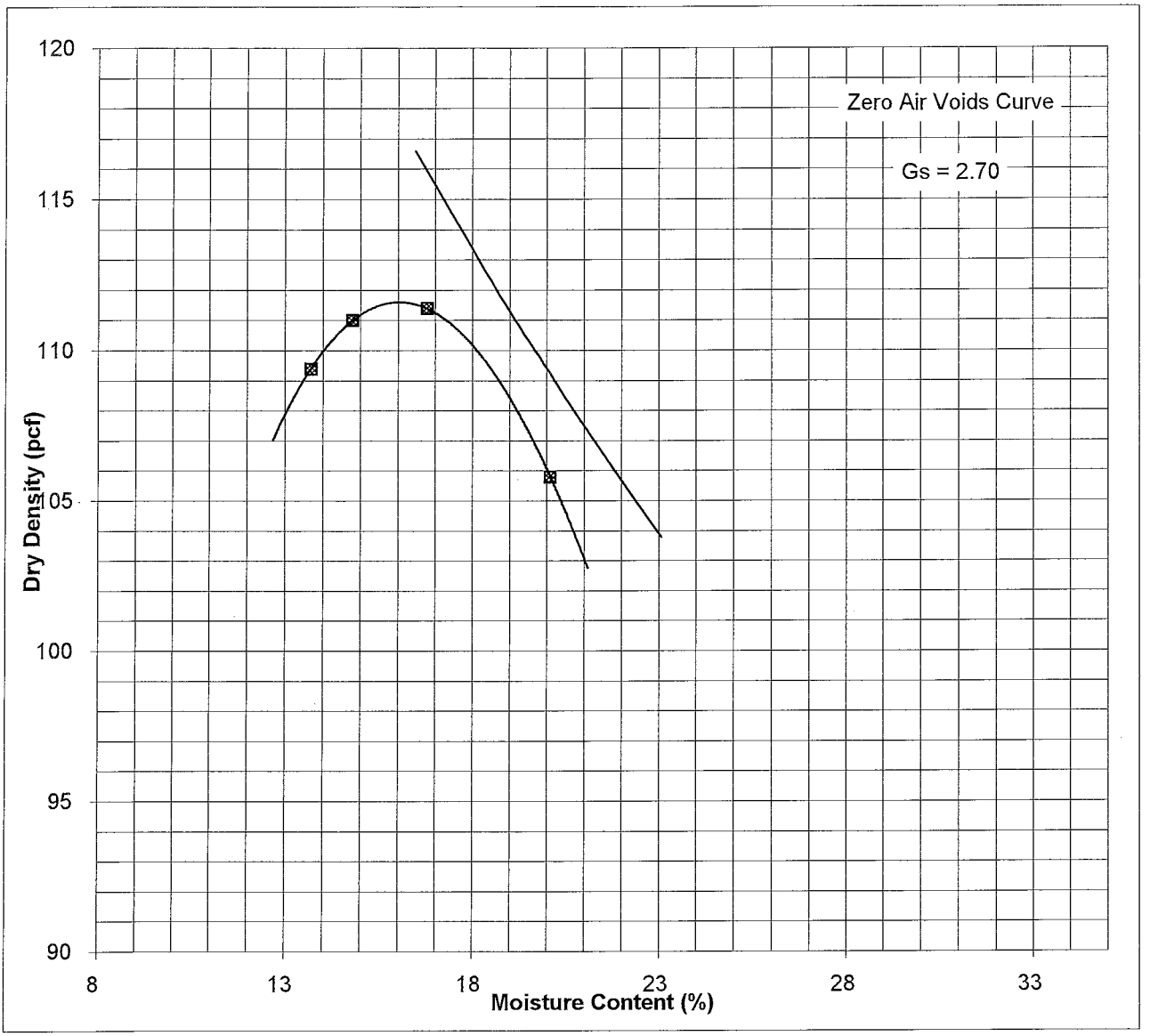
Project No.: 3921

Date: 01/18/10

ECS - Mid-Atlantic, LLC

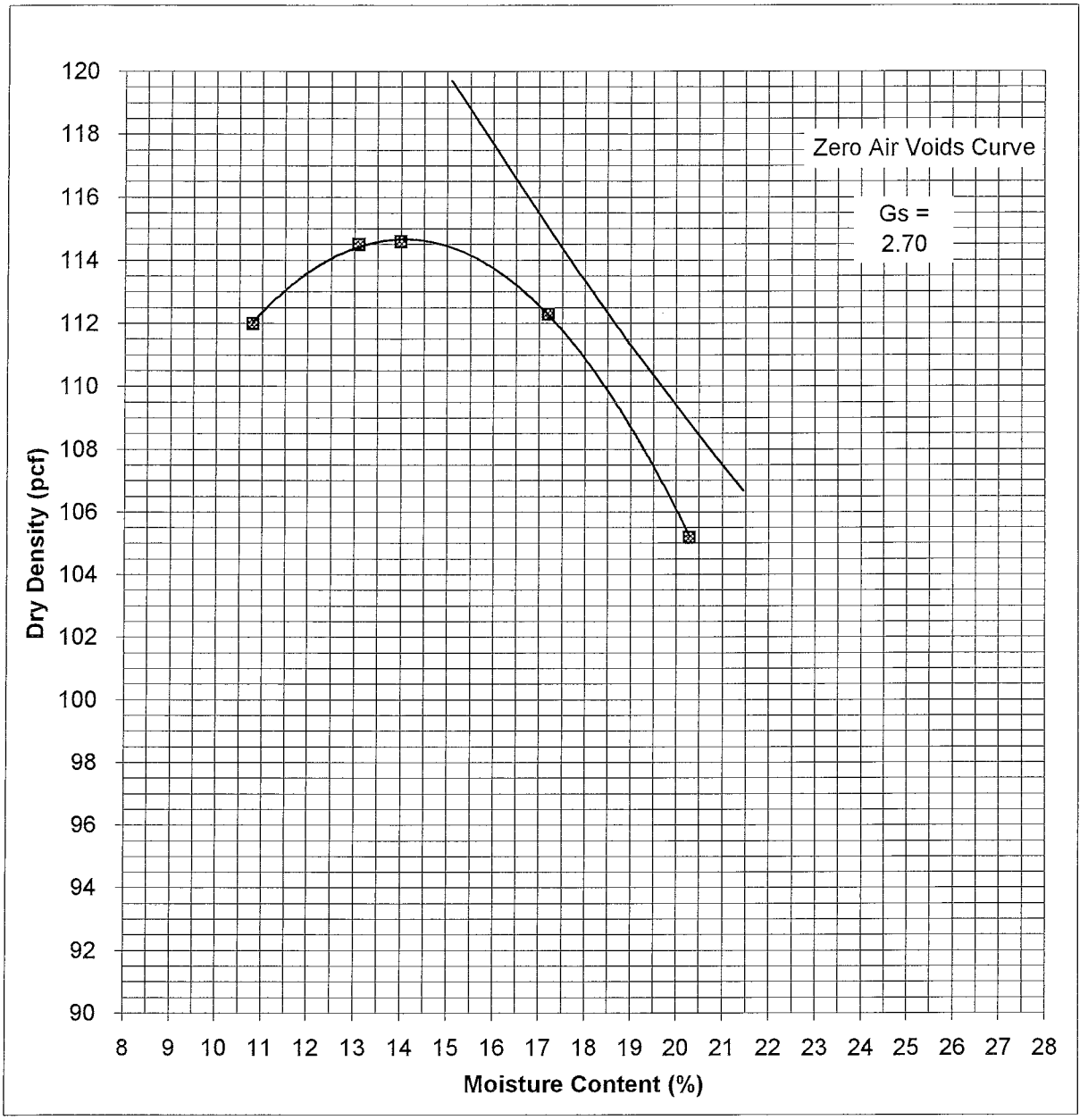
Frederick, Maryland

Grain Size Analysis



Sample No.	ROAD4-BAG	Natural Moisture Content	15.0
Street		Percent Passing No. 200 Sieve	57.7
Station		Percent Retained on No. 4 Sieve	9.7
Liquid Limit (LL)	40	Percent Retained on 3/4" Sieve	0.6
Plastic Limit (PL)	28	Maximum Dry Density (pcf)	111.6
Plasticity Index (PI	12	Optimum Moisture Content (%)	16.1
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	115.4
Description	ORANGISH BROWN SANDY SILT	Corr. Optimum Moisture Content (%)	14.7
Classification	ML	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.70	Percent (%) Gravel Total	9.7
Test Standard	D-698	Test Method	A

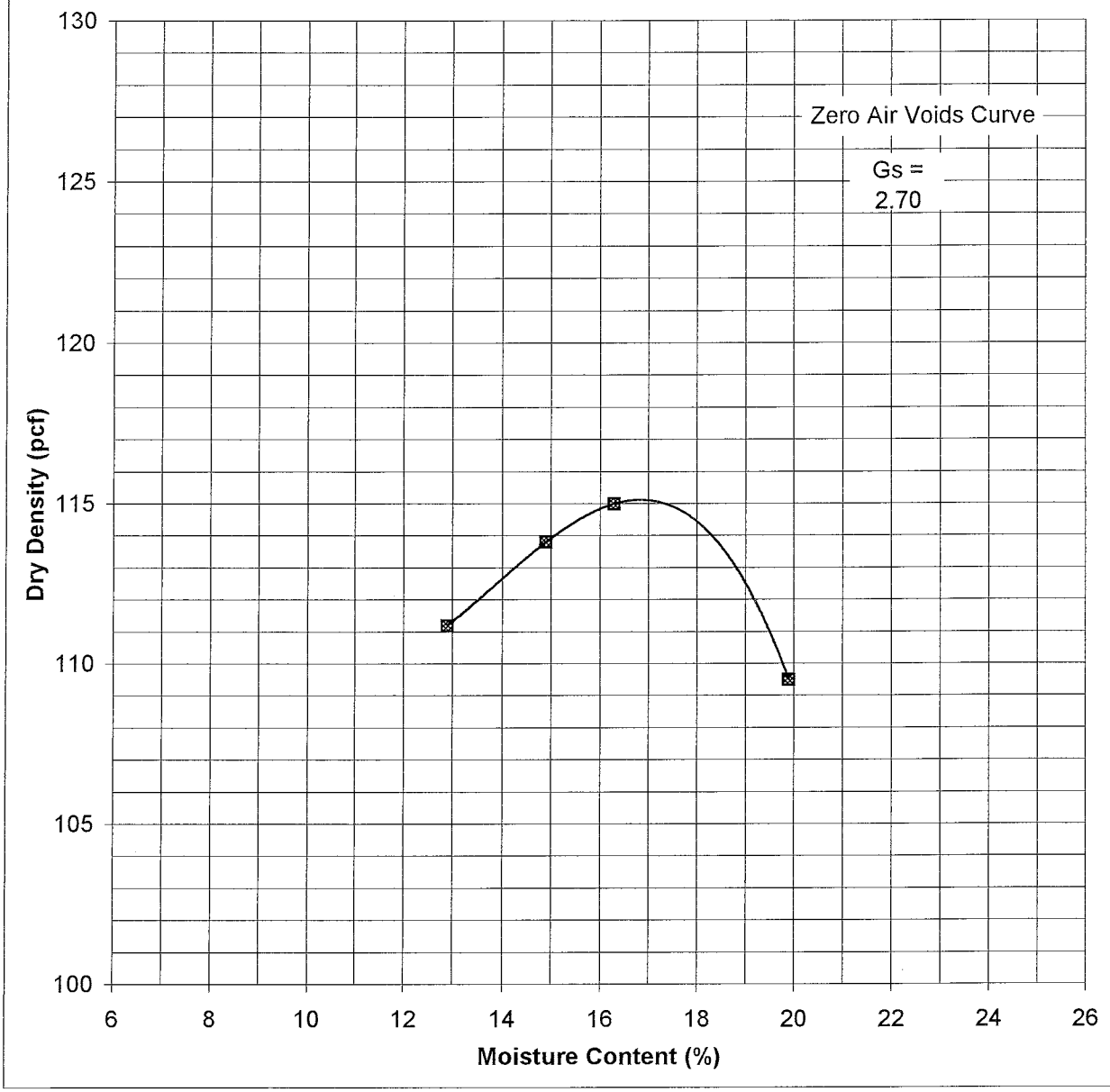
Project: MC BIOSCIENCE	**ECS MID-ATLANTIC, LLC**
Project No.: 3921	**Frederick, Maryland**
Date: 01/18/10	**Moisture Density Relationship Curve**



Sample No.	SWME8-BAG	Natural Moisture Content	
Street		Percent Passing No. 200 Sieve	49.4
Station		Percent Retained on No. 4 Sieve	13.5
Liquid Limit (LL)	38	Percent Retained on 3/4" Sieve	0
Plastic Limit (PL)	29	Maximum Dry Density (pcf)	114.7
Plasticity Index (P	9	Optimum Moisture Content (%)	14.2
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	119.9
Description	REDDISH BROWN SILTY SAND	Corr. Optimum Moisture Content (	12.6
Classification	SM	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.70	Percent (%) Gravel Total	13.5
Test Standard	D-698	Test Method:	A

Project: MC BIOSCIENCE
Project No.: 3921
Date: 01/18/10

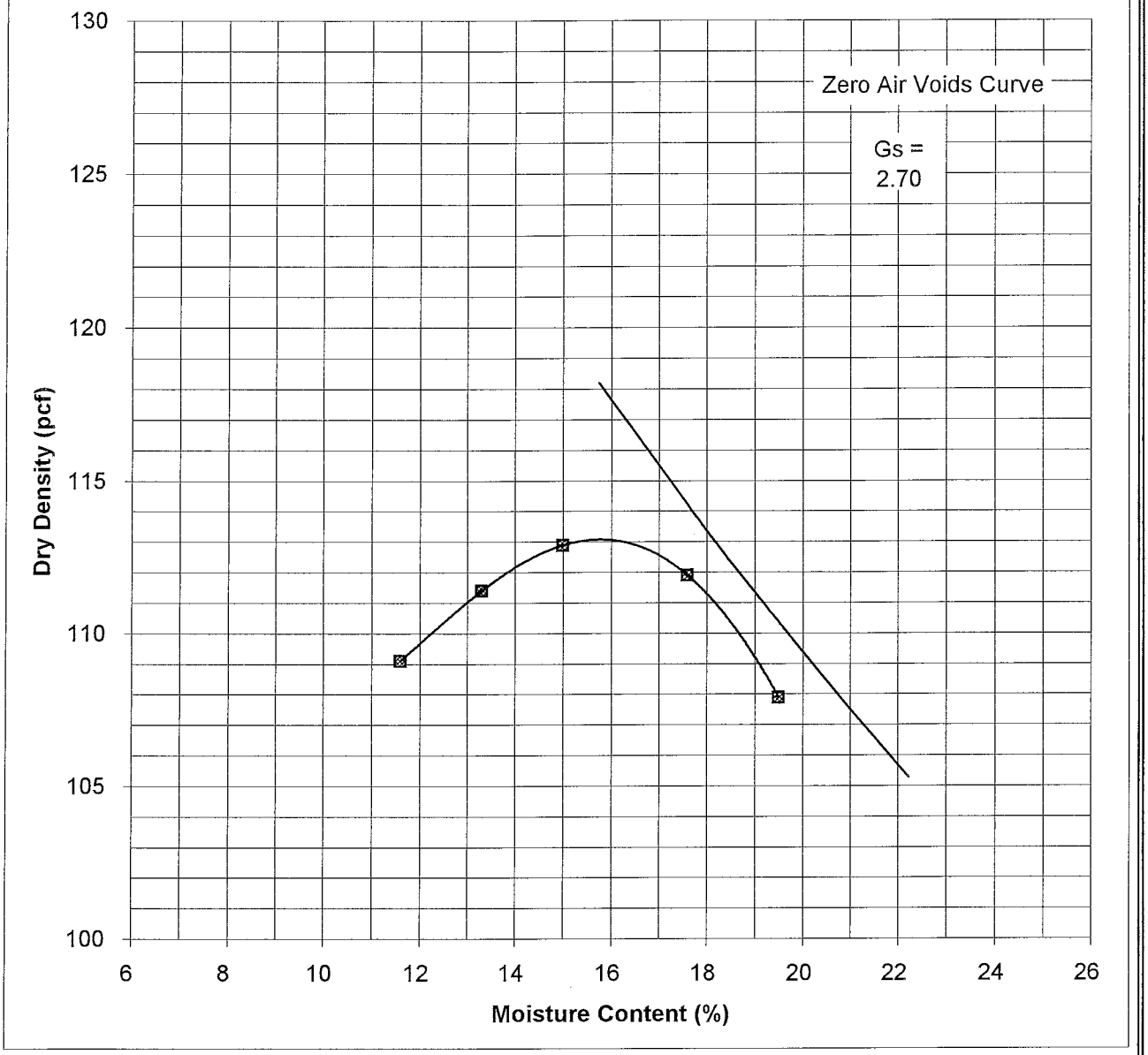
ECS MID-ATLANTIC, LLC
Frederick, Maryland
Moisture Density Relationship Curve



Sample No.	SWMA3-BAG	Natural Moisture Content	
Street		Percent Passing No. 200 Sieve	53.6
Station		Percent Retained on No. 4 Sieve	2.9
Liquid Limit (LL)	47	Percent Retained on 3/4" Sieve	0
Plastic Limit (PL)	29	Maximum Dry Density (pcf)	115.2
Plasticity Index (P	18	Optimum Moisture Content (%)	16.8
Liquidity Index (LI		Corr. Maximum Dry Density (pcf)	116.3
Description	REDDISH BROWN SANDY SILT	Corr. Optimum Moisture Content (%	16.4
Classification	ML	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.70	Percent (%) Gravel Total	2.9
Test Standard	D-698	Test Method:	A

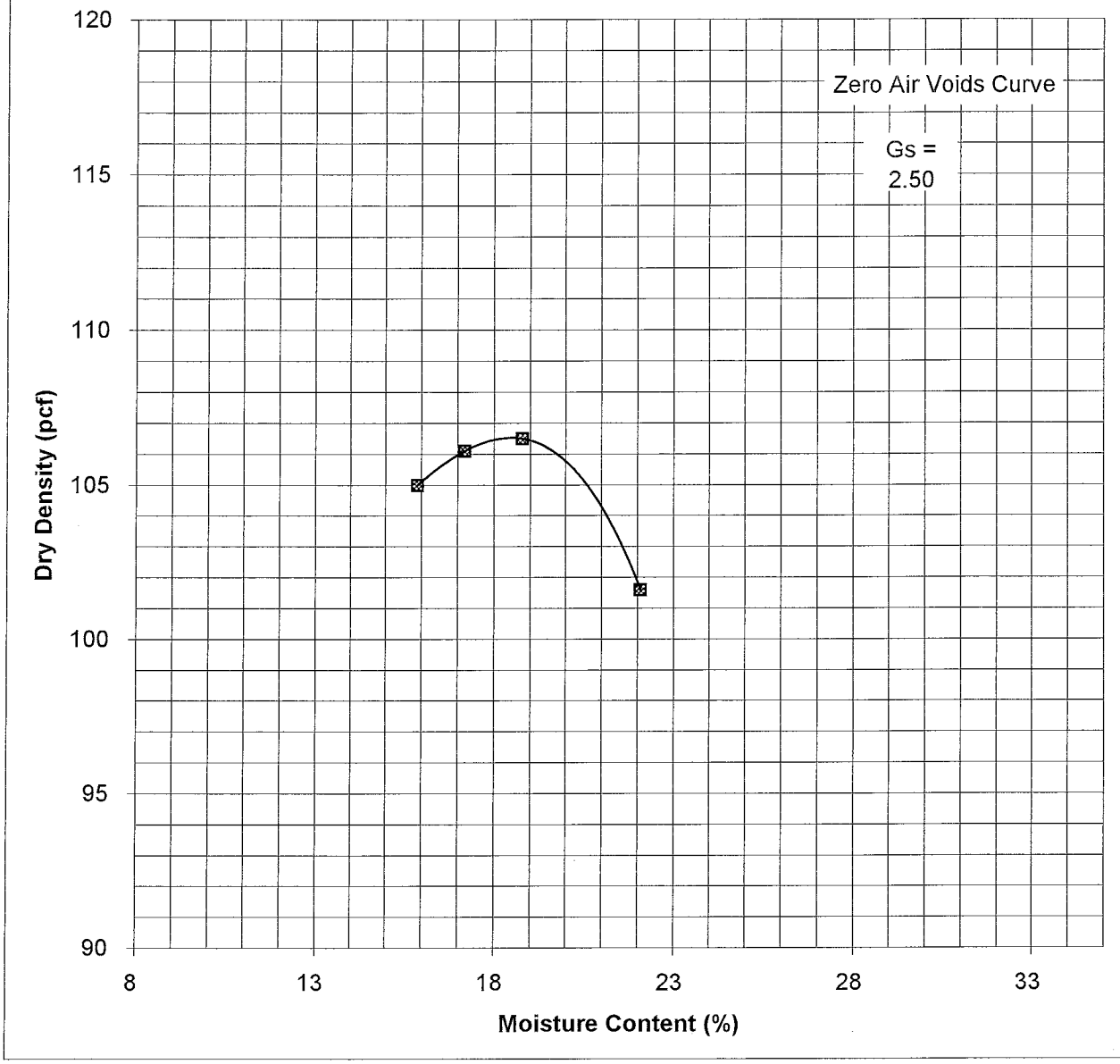
Project: MC BIOSCIENCE
Project No.: 3921
Date: 01/18/10

ECS MID-ATLANTIC, LLC
Frederick, Maryland
Moisture Density Relationship Curve



Sample No.	SWMA2-BAG	Natural Moisture Content	
Street		Percent Passing No. 200 Sieve	56.7
Station		Percent Retained on No. 4 Sieve	1.8
Liquid Limit (LL)	38	Percent Retained on 3/4" Sieve	0
Plastic Limit (PL)	29	Maximum Dry Density (pcf)	113.2
Plasticity Index (P	9	Optimum Moisture Content (%)	15.8
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	113.9
Description	BROWN SANDY SILT	Corr. Optimum Moisture Content	15.6
Classification	ML	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.70	Percent (%) Gravel Total	1.8
Test Standard	D-698	Test Method:	A

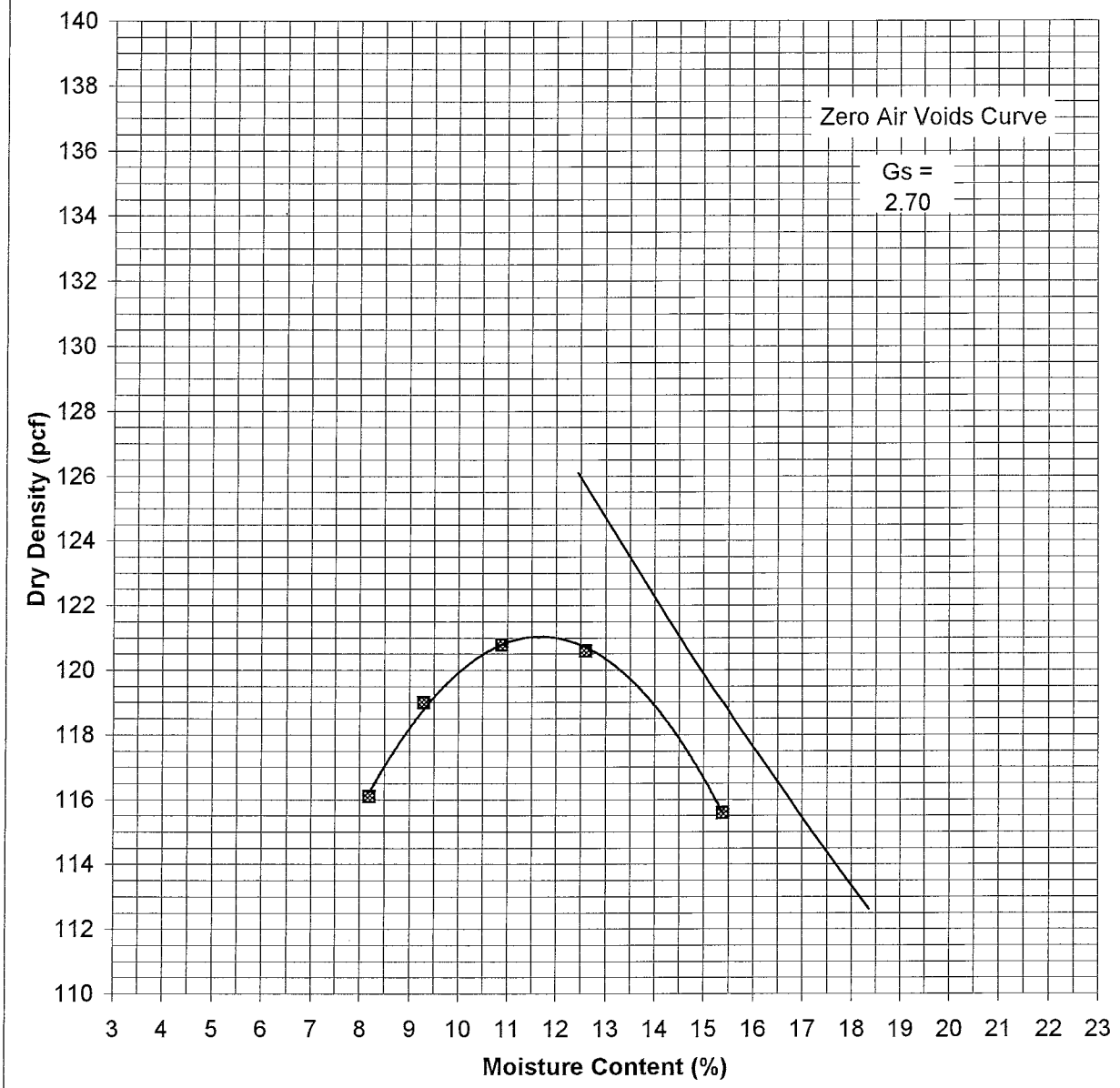
Project: MC BIOSCIENCE	**ECS MID-ATLANTIC, LLC**
Project No.: 3921	**Frederick, Maryland**
Date: 01/18/10	**Moisture Density Relationship Curve**



Sample No.	WSSC6-BAG	Natural Moisture Content	
Street		Percent Passing No. 200 Sieve	69.5
Station		Percent Retained on No. 4 Sieve	6.0
Liquid Limit (LL)	43	Percent Retained on 3/4" Sieve	0
Plastic Limit (PL)	30	Maximum Dry Density (pcf)	106.6
Plasticity Index (P	13	Optimum Moisture Content (%)	18.5
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	108.7
Description	REDDISH BROWN SANDY SILT	Corr. Optimum Moisture Content	17.5
Classification	ML	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.50	Percent (%) Gravel Total	6.0
Test Standard	D-698	Test Method:	A

Project: MC BIOSCIENCE
Project No.: 3921
Date: 01/18/10

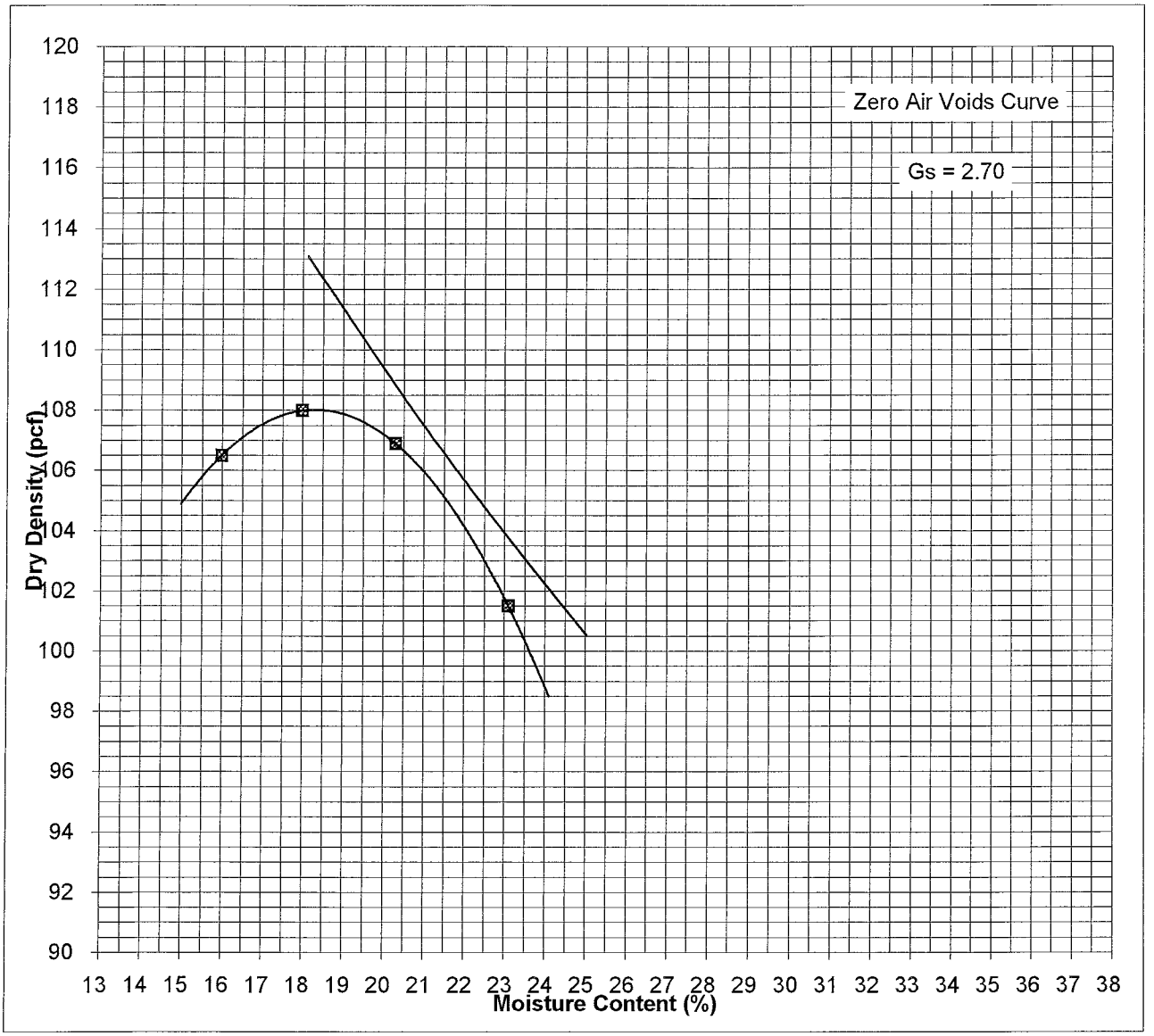
ECS MID-ATLANTIC, LLC
Frederick, Maryland
Moisture Density Relationship Curve



Sample No.	ROAD1-BAG	Natural Moisture Content	
Street		Percent Passing No. 200 Sieve	36.9
Station		Percent Retained on No. 4 Sieve	19.0
Liquid Limit (LL)	34	Percent Retained on 3/4" Sieve	0.4
Plastic Limit (PL)	NP	Maximum Dry Density (pcf)	121.1
Plasticity Index (P	NP	Optimum Moisture Content (%)	11.7
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	127.9
Description	BROWN SILTY SAND W/GRAVEL	Corr. Optimum Moisture Content (%	9.9
Classification	SM	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.70	Percent (%) Gravel Total	19.0
Test Standard	D-698	Test Method:	A

Project: MC BIOSCIENCE
Project No.: 3921
Date: 01/12/10

ECS MID-ATLANTIC, LLC
Frederick, Maryland
Moisture Density Relationship Curve



Sample No.	ROAD5-BAG	Natural Moisture Content	
Street		Percent Passing No. 200 Sieve	57.3
Station		Percent Retained on No. 4 Sieve	13.0
Liquid Limit (LL)	48	Percent Retained on 3/4" Sieve	0.9
Plastic Limit (PL)	33	Maximum Dry Density (pcf)	108.1
Plasticity Index (PI	15	Optimum Moisture Content (%)	18.3
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	113.4
Description	REDDISH BROWN SANDY SILT	Corr. Optimum Moisture Content (%)	16.2
Classification	ML	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.70	Percent (%) Gravel Total	13.0
Test Standard	D-698	Test Method	A

Project: MC BIOSCIENCE

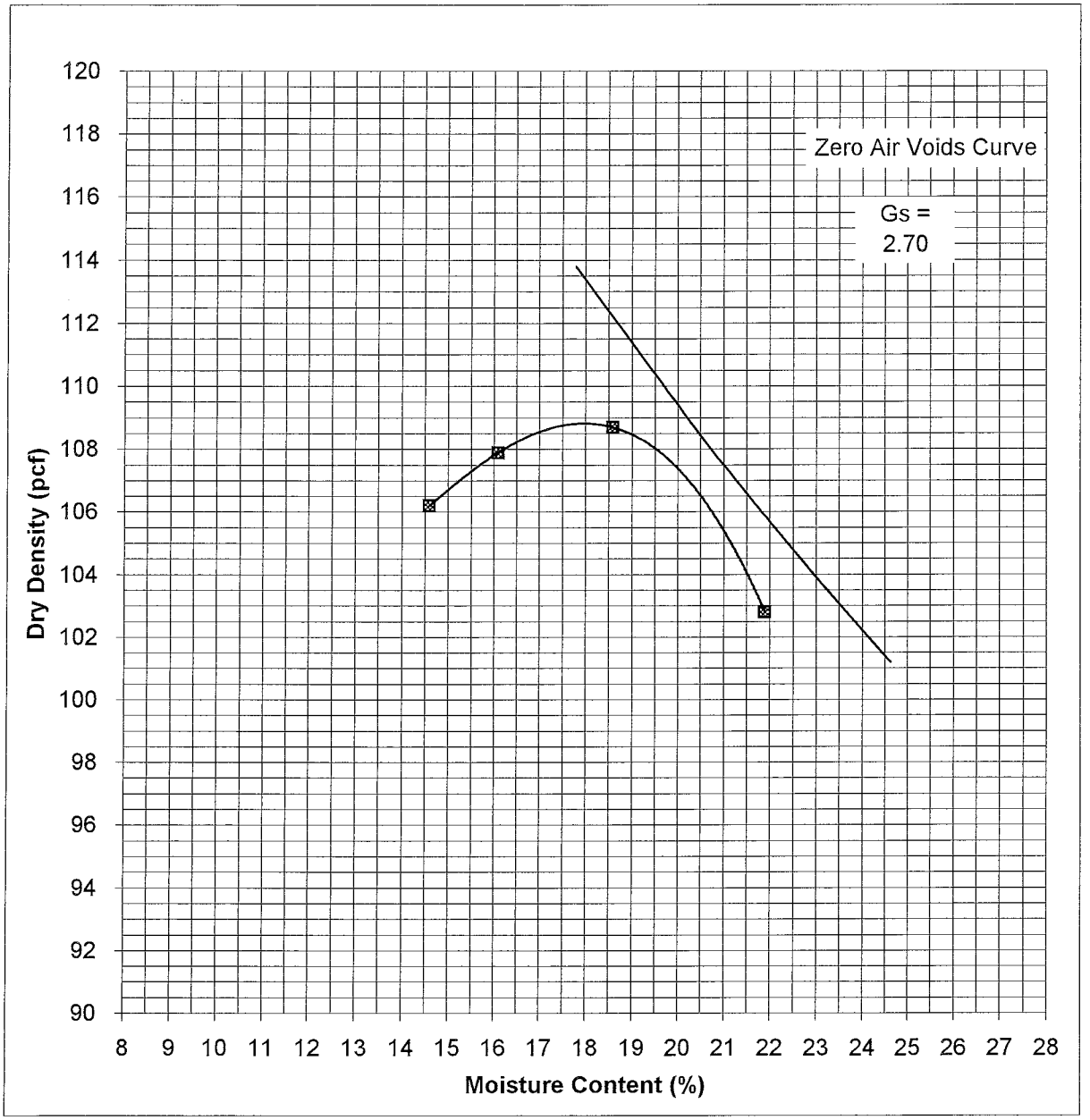
Project No.: 3921

Date: 01/12/10

ECS MID-ATLANTIC, LLC

Frederick, Maryland

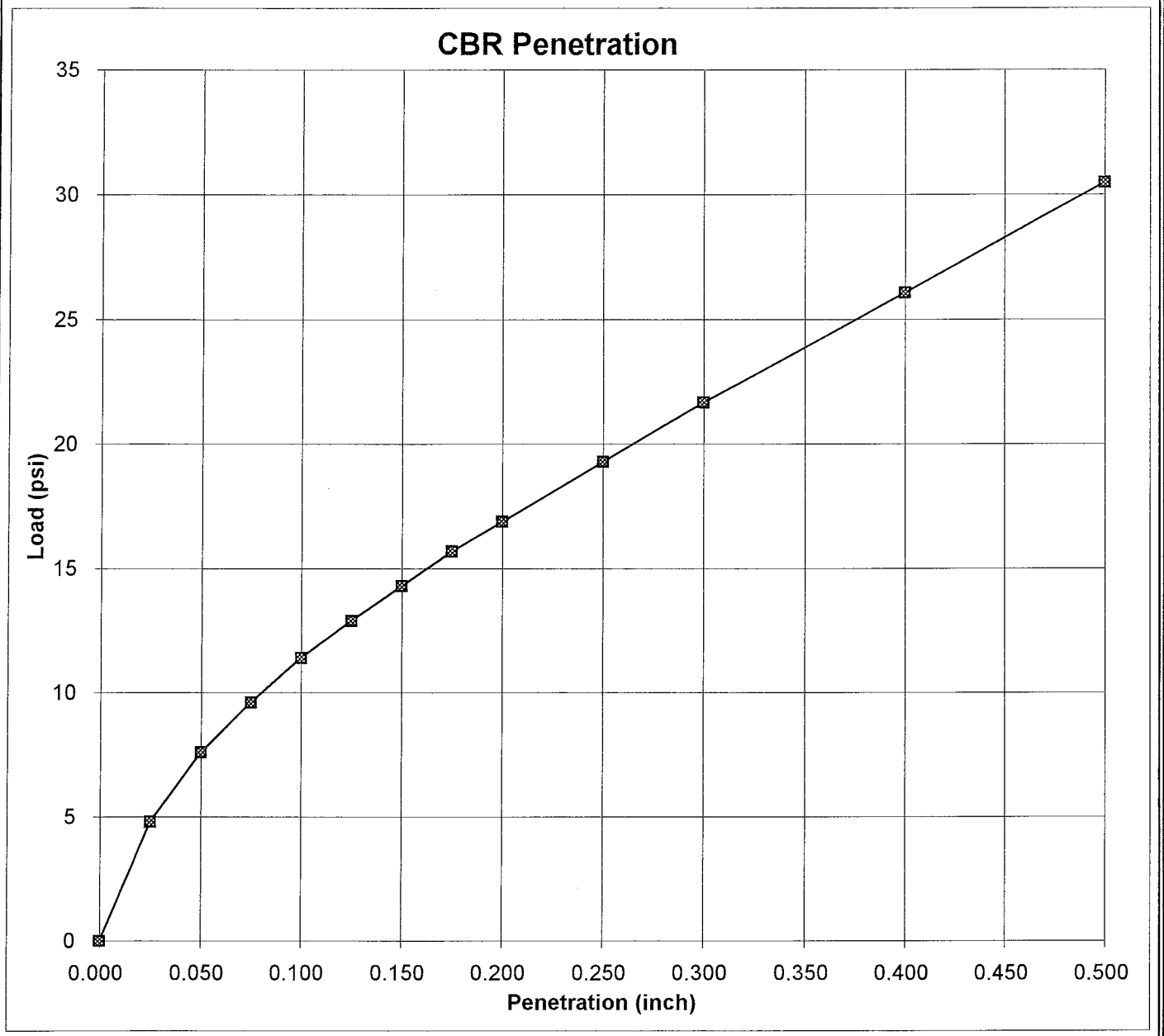
Moisture Density Relationship Curve



Sample No.	ROAD7-BAG	Natural Moisture Content	
Street		Percent Passing No. 200 Sieve	46.5
Station		Percent Retained on No. 4 Sieve	9.8
Liquid Limit (LL)	39	Percent Retained on 3/4" Sieve	0
Plastic Limit (PL)	29	Maximum Dry Density (pcf)	108.8
Plasticity Index (P	10	Optimum Moisture Content (%)	18.0
Liquidity Index (LI)		Corr. Maximum Dry Density (pcf)	112.7
Description	BROWN SILTY SAND	Corr. Optimum Moisture Content (	16.4
Classification	SM	Percent (%) Gravel as Tested	0.0
Specific Gravity	2.70	Percent (%) Gravel Total	9.8
Test Standard	D-698	Test Method:	A

Project: MC BIOSCIENCE
Project No.: 3921
Date: 01/12/10

ECS MID-ATLANTIC, LLC
Frederick, Maryland
Moisture Density Relationship Curve



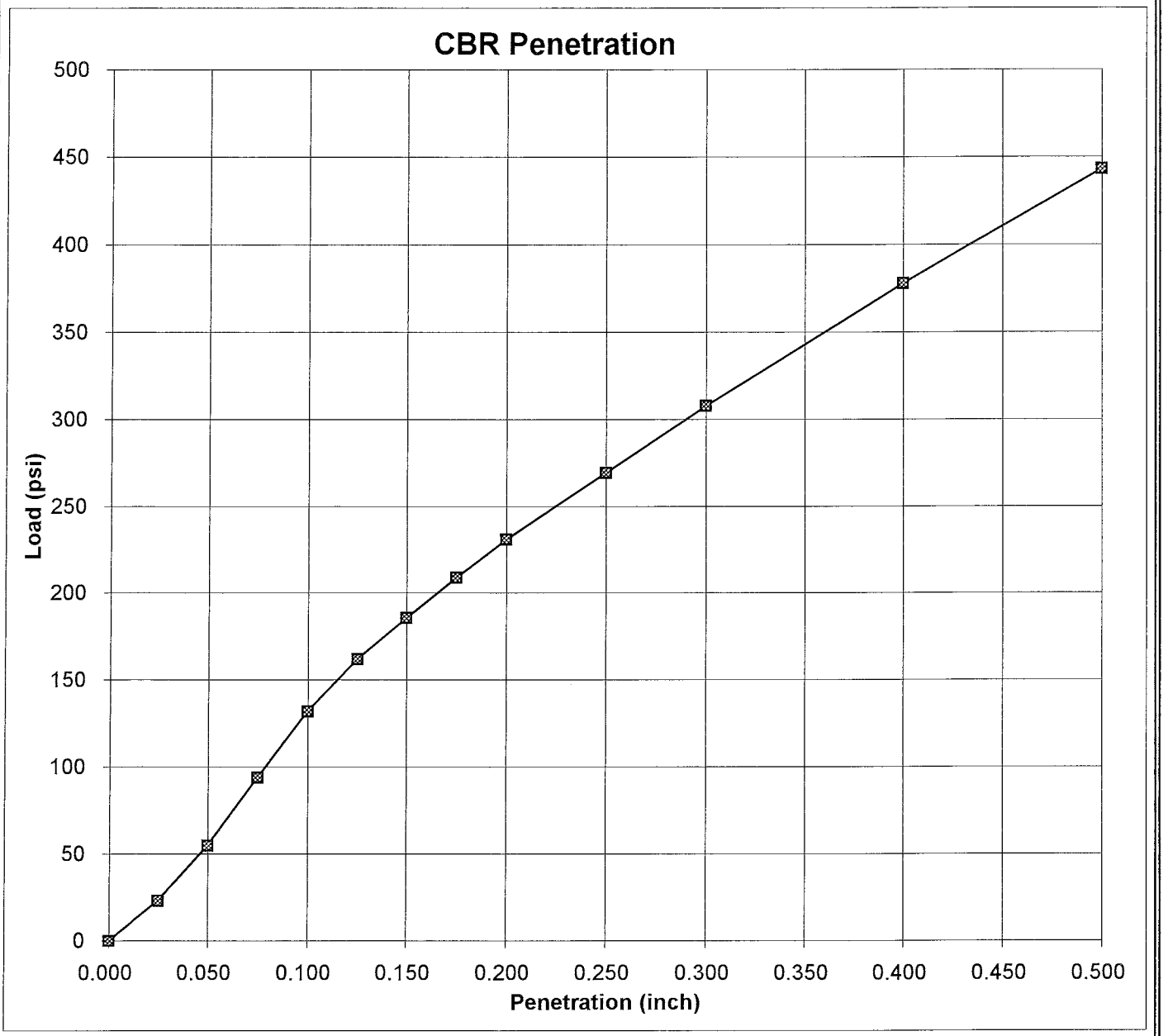
Sample No.: ROAD1-BAG	Street: 0
Description: BROWN SILTY SAND W/GRAVEL	Station No.: 0
Classification: SM	Test Method: D-1883

Maximum Dry Density (pcf)	127.9
Opt. Moisture Content (%)	9.9
Natural Moisture Content	
Liquid Limit (LL)	34
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	0.4
Percent Retained No. 4 Sieve	19.0
Percent Passing No.200 Sieve	36.9

	CBR 1
Corrected CBR @ 0.1"	1.1
Corrected CBR @ 0.2"	1.1
Proctor Method	D-698
Dry Density as Molded	110.0
Molded Moisture Content	8.3
Percent of Maximum Density	86.0
Moisture Content +/- Opt	-1.6
Percent (%)Swell	0.6

Project: MC BIOSCIENCE
Project No.: 3921
Date: 01/18/10

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves



Sample No.:	ROAD1-BAG	Street:	0
Description:	BROWN SILTY SAND W/GRAVEL	Station No.:	0
Classification:	SM	Test Method:	D-1883

Maximum Dry Density (pcf)	127.9		CBR 3
Opt. Moisture Content (%)	9.9	Corrected CBR @ 0.1"	13.2
Natural Moisture Content		Corrected CBR @ 0.2"	15.4
Liquid Limit (LL)	34	Proctor Method	D-698
Plastic Limit (PL)	NP	Dry Density as Molded	127.5
Plasticity Index (PI)	34	Molded Moisture Content	8.3
Liquidity Index (LI)		Percent of Maximum Density	99.7
Percent Retained 3/4" Sieve	0.4	Moisture Content +/- Opt	-1.6
Percent Retained No. 4 Sieve	19.0	Percent (%)Swell	0.8
Percent Passing No.200 Sieve	36.9		

Project: MC BIOSCIENCE **Project No.:** 3921 **Date:** 01/18/10	**ECS MID-ATLANTIC, LLC** **Frederick, Maryland** **California Bearing Ratio Curves**

Engineering Consulting Services, Ltd.
Frederick, Maryland

California Bearing Ratio
ASTM D-1883

Date: 18-Jan-10

Project Name: MC BIOSCIENCE
Project Number: 3921

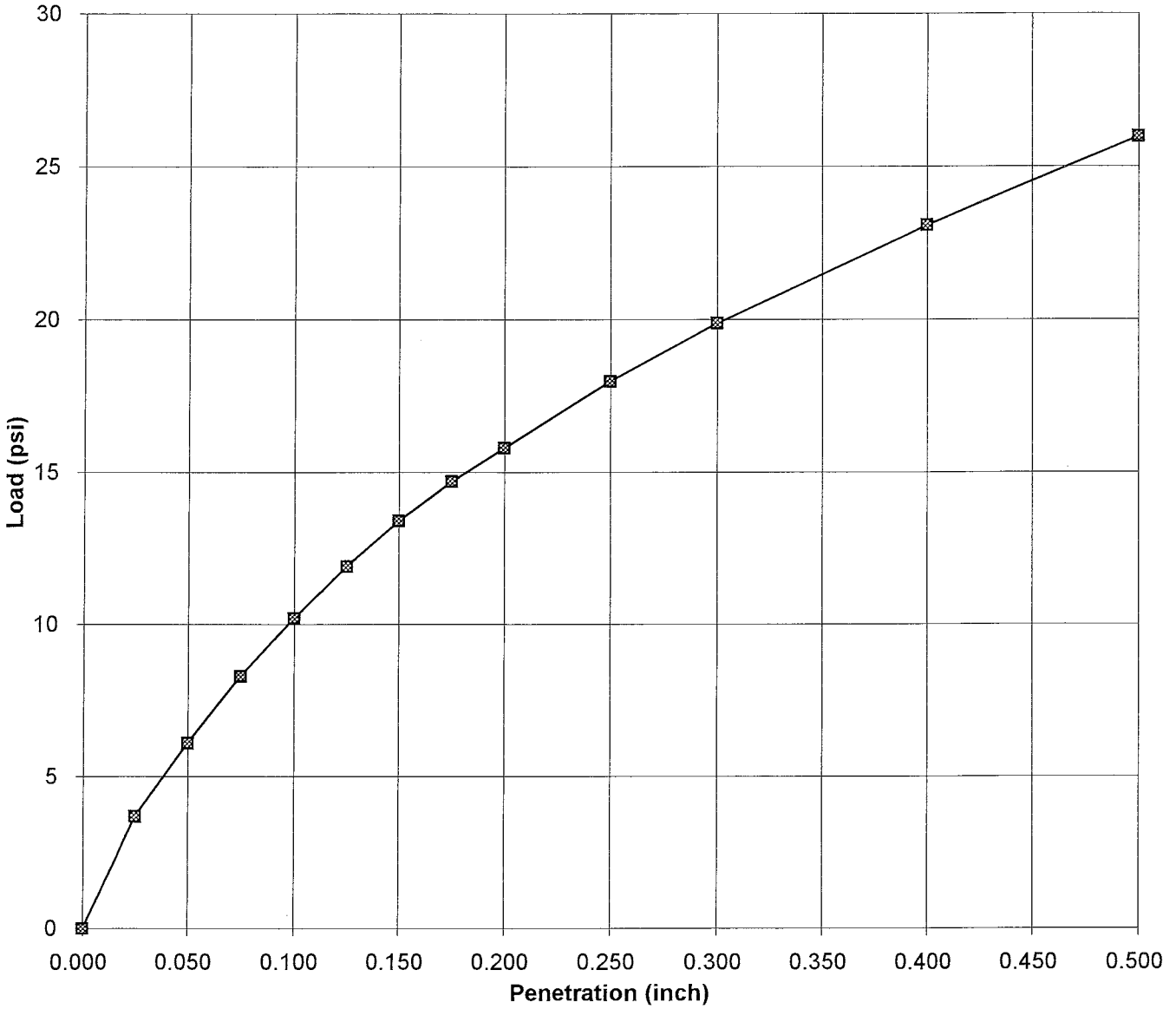
Reported By:

Sample Number: ROAD1-BAG Description: BROWN SILTY SAND W/GRAVEL
Location: 0

Weight of Hammer (lbs):	5.5	Proctor Method:	D-698	Maximum Dry Density (pcf):	127.9
Number of Layers:	3	Percent +4 Material:	19.0	Optimum Moisture Content (%):	9.9
Surcharge (lbs):	10				

Blows per Lift	CBR @ 0.1"	CBR @ 0.2"	Percent of Maximum Density	Molded +/ Optimum Moisture Content (%)	Molded Dry Density (pcf)	Molded Moisture Content (%)	Dry Density after Soaking (pcf)	Moisture Content after Soaking (%)	Change in Moisture Content (%)	Swell (%)
10	1.1	1.1	86.0	-1.6	110.0	8.3	110.8	16.1	7.8	0.6
56	13.2	15.4	99.7	-1.6	127.5	8.3	127.6	11.2	2.9	0.8

CBR Penetration



Sample No.: ROAD5-BAG	Street: 0
Description: REDDISH BROWN SANDY SILT	Station No.: 0
Classification: ML	Test Method: D-1883

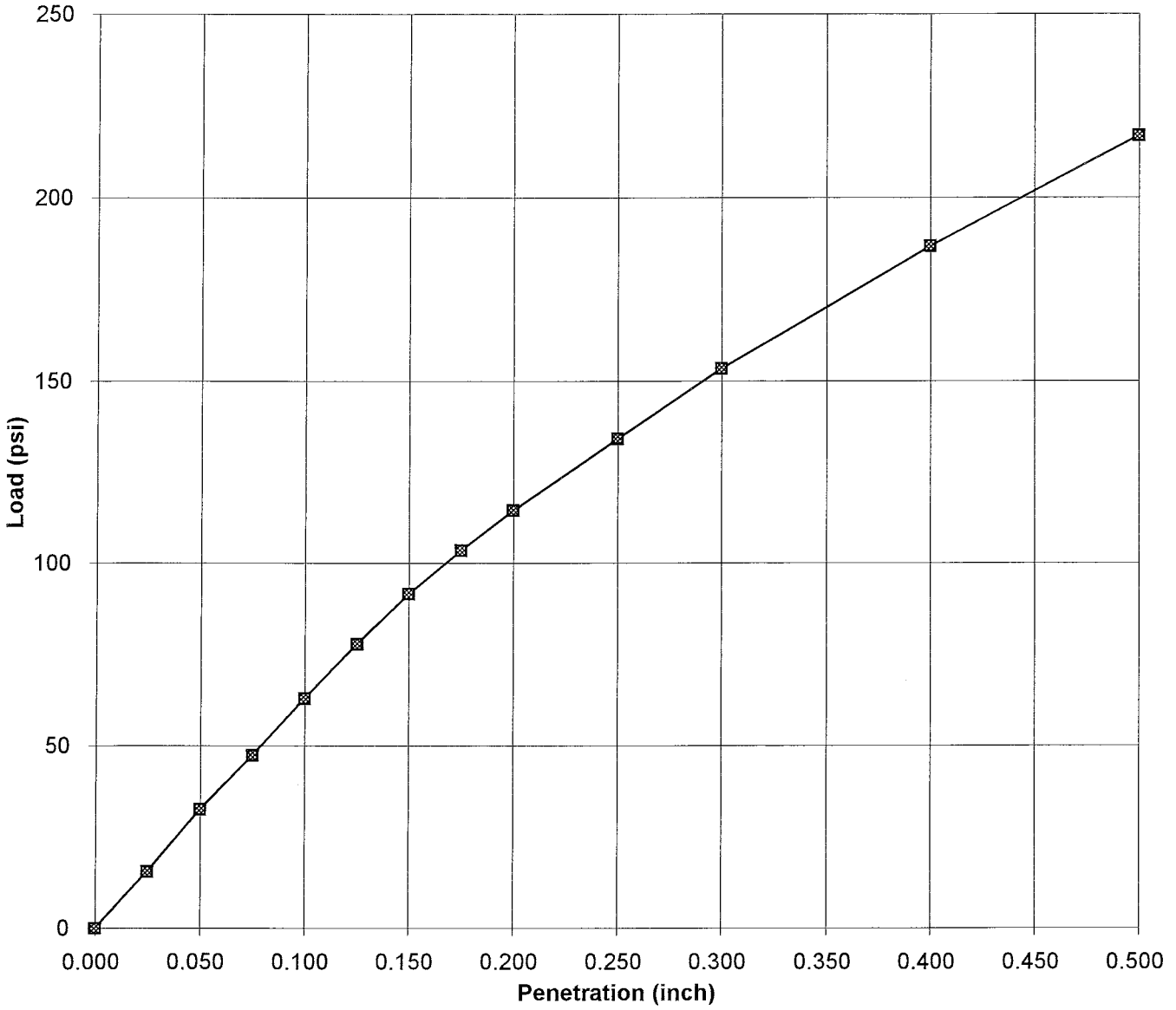
Maximum Dry Density (pcf)	113.4
Opt. Moisture Content (%)	16.2
Natural Moisture Content	
Liquid Limit (LL)	48
Plastic Limit (PL)	33
Plasticity Index (PI)	15
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	0.9
Percent Retained No. 4 Sieve	13.0
Percent Passing No.200 Sieve	57.3

	CBR 1
Corrected CBR @ 0.1"	1.0
Corrected CBR @ 0.2"	1.1
Proctor Method	D-698
Dry Density as Molded	93.2
Molded Moisture Content	15.4
Percent of Maximum Density	82.2
Moisture Content +/- Opt	-0.8
Percent (%)Swell	1.1

Project: MC BIOSCIENCE
Project No.: 3921
Date: 01/18/10

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

CBR Penetration



Sample No.: ROAD5-BAG	Street: 0
Description: REDDISH BROWN SANDY SILT	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	113.4		CBR 3
Opt. Moisture Content (%)	16.2	Corrected CBR @ 0.1"	6.3
Natural Moisture Content		Corrected CBR @ 0.2"	7.6
Liquid Limit (LL)	48	Proctor Method	D-698
Plastic Limit (PL)	33	Dry Density as Molded	112.1
Plasticity Index (PI)	15	Molded Moisture Content	15.4
Liquidity Index (LI)		Percent of Maximum Density	98.9
Percent Retained 3/4" Sieve	0.9	Moisture Content +/- Opt	-0.8
Percent Retained No. 4 Sieve	13.0	Percent (%)Swell	1.4
Percent Passing No.200 Sieve	57.3		

Project: MC BIOSCIENCE
Project No.: 3921
Date: 01/18/10

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

Engineering Consulting Services, Ltd.
Frederick, Maryland

California Bearing Ratio
ASTM D-1883

Date: 18-Jan-10

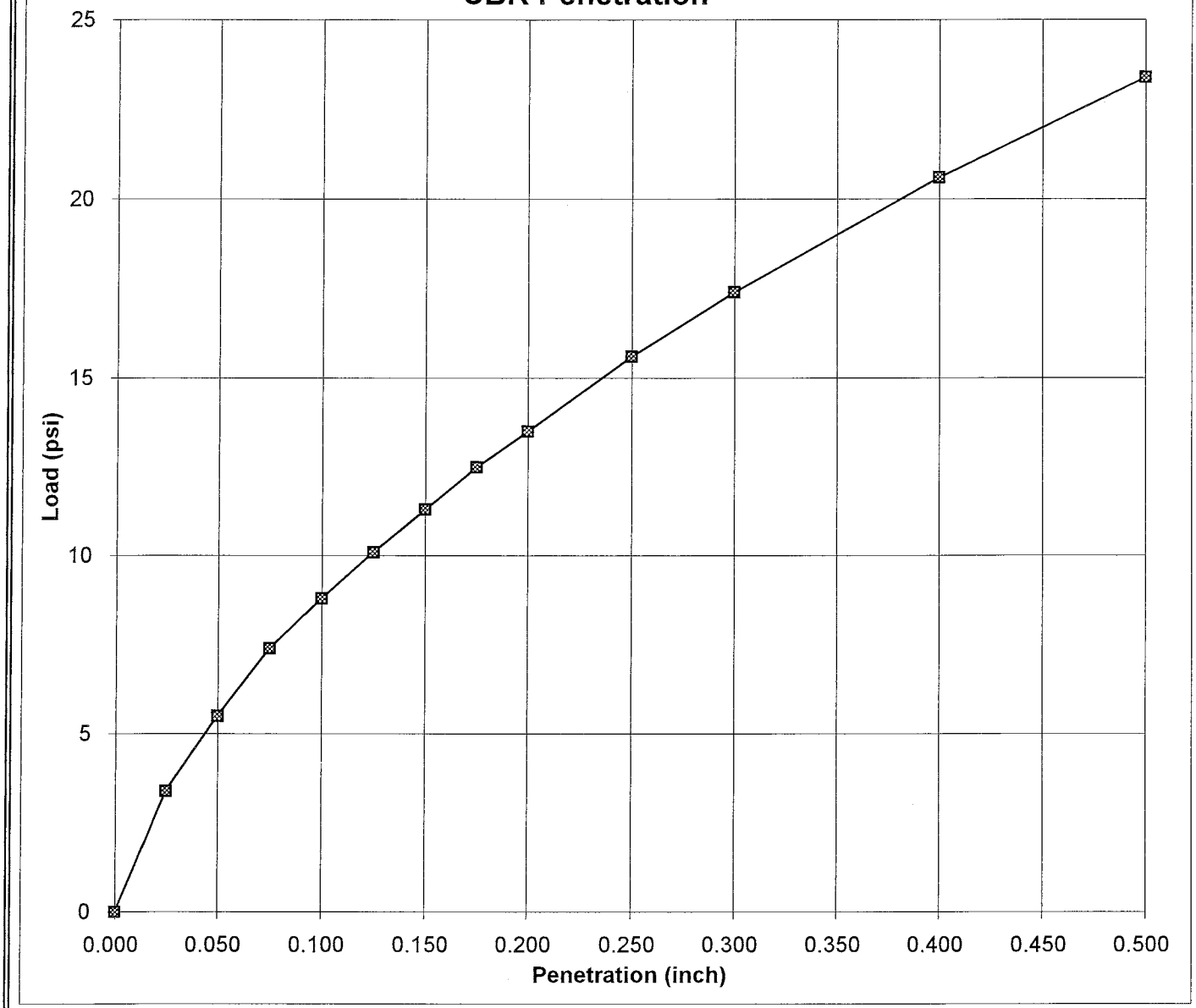
Project Name: MC BIOSCIENCE
Project Number: 3921

Reported By:

Sample Number: ROAD5-BAG Description: REDDISH BROWN SANDY SILT
Location: 0

Weight of Hammer (lbs):	5.5	Proctor Method:	D-698	Maximum Dry Density (pcf):	113.4
Number of Layers:	3	Percent +4 Material:	13.0	Optimum Moisture Content (%):	16.2
Surcharge (lbs):	10				

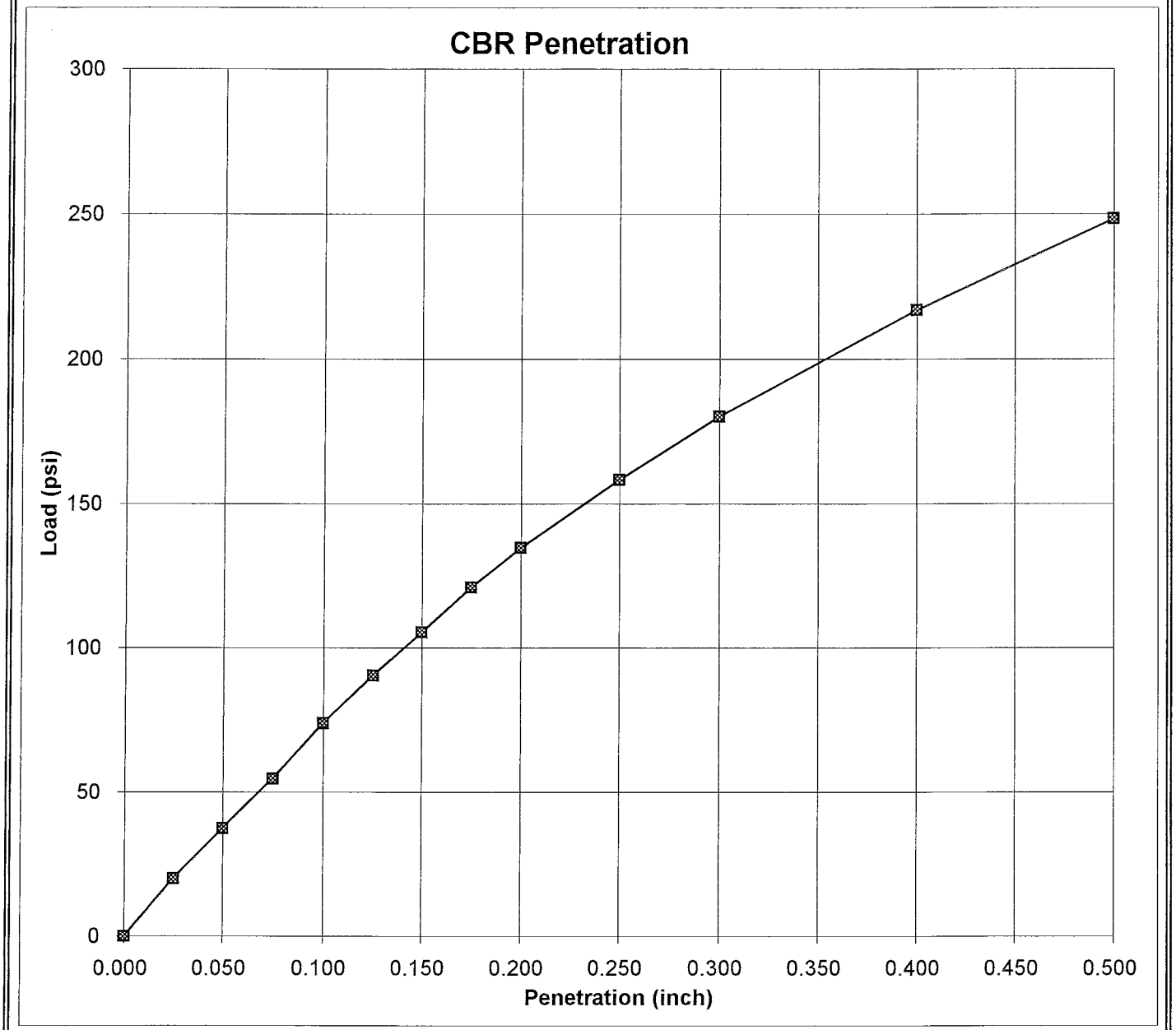
Blows per Lift	CBR @ 0.1"	CBR @ 0.2"	Percent of Maximum Density	Molded +/ Optimum Moisture Content (%)	Molded Dry Density (pcf)	Molded Moisture Content (%)	Dry Density after Soaking (pcf)	Moisture Content after Soaking (%)	Change in Moisture Content (%)	Swell (%)
10	1.0	1.1	82.2	-0.8	93.2	15.4	93.9	24.9	9.5	1.1
56	6.3	7.6	98.9	-0.8	112.1	15.4	111.5	18.4	3.0	1.4



Sample No.: ROAD7-BAG	Street: 0
Description: BROWN SILTY SAND	Station No.: 0
Classification: SM	Test Method: D-1883

Maximum Dry Density (pcf)	112.7		CBR 1
Opt. Moisture Content (%)	16.4	Corrected CBR @ 0.1"	0.9
Natural Moisture Content		Corrected CBR @ 0.2"	0.9
Liquid Limit (LL)	39	Proctor Method	D-698
Plastic Limit (PL)	29	Dry Density as Molded	96.6
Plasticity Index (PI)	10	Molded Moisture Content	16.4
Liquidity Index (LI)		Percent of Maximum Density	85.7
Percent Retained 3/4" Sieve		Moisture Content +/- Opt	0.0
Percent Retained No. 4 Sieve	9.8	Percent (%)Swell	1.3
Percent Passing No.200 Sieve	46.5		

Project: MC BIOSCIENCE **Project No.:** 3921 **Date:** 01/18/10	**ECS MID-ATLANTIC, LLC** **Frederick, Maryland** **California Bearing Ratio Curves**



Sample No.: ROAD7-BAG	Street: 0
Description: BROWN SILTY SAND	Station No.: 0
Classification: SM	Test Method: D-1883

Maximum Dry Density (pcf)	112.7		CBR 3
Opt. Moisture Content (%)	16.4	Corrected CBR @ 0.1"	7.4
Natural Moisture Content		Corrected CBR @ 0.2"	9.0
Liquid Limit (LL)	39	Proctor Method	D-698
Plastic Limit (PL)	29	Dry Density as Molded	111.0
Plasticity Index (PI)	10	Molded Moisture Content	16.4
Liquidity Index (LI)		Percent of Maximum Density	98.5
Percent Retained 3/4" Sieve		Moisture Content +/- Opt	0.0
Percent Retained No. 4 Sieve	9.8	Percent (%)Swell	0.9
Percent Passing No.200 Sieve	46.5		

Project: MC BIOSCIENCE **Project No.:** 3921 **Date:** 01/18/10	**ECS MID-ATLANTIC, LLC** **Frederick, Maryland** **California Bearing Ratio Curves**

Engineering Consulting Services, Ltd.
Frederick, Maryland

California Bearing Ratio
ASTM D-1883

Date: 18-Jan-10

Project Name: MC BIOSCIENCE
Project Number: 3921

Reported By:

Sample Number: ROAD7-BAG Description: BROWN SILTY SAND
Location: 0

Weight of Hammer (lbs):	5.5	Proctor Method:	D-698	Maximum Dry Density (pcf):	112.7
Number of Layers:	3	Percent +4 Material:	9.8	Optimum Moisture Content (%):	16.4
Surcharge (lbs):	10				

Blows per Lift	CBR @ 0.1"	CBR @ 0.2"	Percent of Maximum Density	Molded +/ Optimum Moisture Content (%)	Molded Dry Density (pcf)	Molded Moisture Content (%)	Dry Density after Soaking (pcf)	Moisture Content after Soaking (%)	Change in Moisture Content (%)	Swell (%)
10	0.9	0.9	85.7	0.0	96.6	16.4	96.8	22.3	5.9	1.3
56	7.4	9.0	98.5	0.0	111.0	16.4	111.8	17.0	0.6	0.9

REFERENCE NOTES FOR BORING LOGS

I. Drilling Sampling Symbols

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, BX, AX	PM	Pressuremeter
DC	Dutch Cone Penetrometer	RD	Rock Bit Drilling
BS	Bulk Sample of Cuttings	PA	Power Auger (no sample)
HSA	Hollow Stem Auger	WS	Wash sample
REC	Rock Sample Recovery %	RQD	Rock Quality Designation %

II. Correlation of Penetration Resistances to Soil Properties

Standard Penetration (blows/ft) refers to the blows per foot of a 140 lb. hammer falling 30 inches on a 2-inch OD split-spoon sampler, as specified in ASTM D 1586. The blow count is commonly referred to as the N-value.

A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

Density		*Relative Properties*	
Under 4 blows/ft	Very Loose	Adjective Form	12% to 49%
5 to 10 blows/ft	Loose	With	5% to 12%
11 to 30 blows/ft	Medium Dense		
31 to 50 blows/ft	Dense		
Over 51 blows/ft	Very Dense		

Particle Size Identification		
Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ inch
Sand	Coarse	2.00 mm to ¼ inch (dia. of lead pencil)
	Medium	0.42 to 2.00 mm (dia. of broom straw)
	Fine	0.074 to 0.42 mm (dia. of human hair)
Silt and Clay		0.0 to 0.074 mm (particles cannot be seen)

B. Cohesive Soils (Clay, Silt, and Combinations)

Blows/ft	*Consistency*	*Unconfined Comp. Strength Q_p (tsf)*	*Degree of Plasticity*	*Plasticity Index*
Under 2	Very Soft	Under 0.25	None to slight	0 – 4
3 to 4	Soft	0.25-0.49	Slight	5 – 7
5 to 8	Medium Stiff	0.50-0.99	Medium	8 – 22
9 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.00		
31 to 50	Hard	4.00–8.00		
Over 51	Very Hard	Over 8.00		

III. Water Level Measurement Symbols

WL	Water Level	BCR	Before Casing Removal	DCI	Dry Cave-In
WS	While Sampling	ACR	After Casing Removal	WCI	Wet Cave-In
WD	While Drilling	▽	Est. Groundwater Level	▼	Est. Seasonal High GWT

The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally applied.

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 580.79

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
0						580
	1	SS	18	8		
	2	SS	18	12		
5						575
	3	SS	18	12		
	4	SS	18	8		
10						570
	5	SS	5	5		
15						565
	6	SS	18	10		
20						560
25						555
30						

Topsoil Depth 2"

Silty SAND, With Rock Fragments, Brown, Gray and Red, Moist, Firm to Medium Dense, (SM)

Silty SAND, With Decomposed Rock Fragments, Gray and Red, Moist, Medium Dense, (SM)

Decomposed Rock, Brown, Moist, Very Dense

END OF BORING @ 20.0'

⊗ 7 (5-4-3) ● 15.0 ⊗ 17 (4-7-10) ● 15.9 ⊗ 25 (6-9-16) ● 10.4 ⊗ 62 (21-27-35)

NP — Δ 34

(50/5) ⊗ 50/5

⊗ 67 (38-31-36)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 14.7' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

Gratkowski(1/3/2010 9:02:31 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)
PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ
ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.% ——— (20% 40% 60% 80% 100%)
⊗ STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50+)

DESCRIPTION OF MATERIAL ENGLISH UNITS
BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%
SURFACE ELEVATION 525.20

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0						
						Topsoil Depth 6"
	1	SS	18	10		7 (2-3-4)
						Clayey SILT, With Sand, Orangish Brown, Moist, Firm, (ML)
	2	SS	18	18		8 (3-3-5)
5					520	Silty SAND, Gray, Orange and Brown, Moist, Firm to Medium Dense (SM)
	3	SS	18	18		19 (6-7-12)
	4	SS	18	18		17 (5-7-10)
10					515	END OF BORING @ 10.0'
15					510	
20					505	
25					500	
30						

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 6'5" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRalkowski(1/5/2010 3:57:25 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 487.65

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 4"		485	
	1	SS	18	16	Sandy SILT, Trace Rock Fragments, Reddish Brown, Moist, Firm, (ML)			⊗ 10 (3-4-6)
5	2	SS	18	14	Silty SAND, With Decomposed Rock Fragments, Reddish Brown, Moist, Medium Dense to Dense, (SM)		480	⊗ 21 (5-9-12)
	3	SS	18	14				⊗ 26 (7-11-15)
	4	SS	18	10			475	(10-14-19) ⊗ 33
10					END OF BORING @ 10.0'			
15							470	
20							465	
25							460	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 6.8' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/5/2010 4:00:36 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-4	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)
PLASTIC LIMIT % (X) — WATER CONTENT % (●) — LIQUID LIMIT % (△)
ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% — 20% 40% 60% 80% 100%
STANDARD PENETRATION BLOWS/FT. (⊗) 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS
BOTTOM OF CASING — LOSS OF CIRCULATION 100%
SURFACE ELEVATION 486.28

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)
0					Topsoil Depth 4"	
	1	SS	18	12	SILT, Trace Clay, Orangish Brown, Moist, Firm, (ML)	485
5	2	SS	18	16	Sandy SILT, With Decomposed Rock Fragments, Brown, Moist, Medium Dense to Very Dense, (ML)	
	3	SS	18	16		480
	4	SS	18	12		
10					END OF BORING @ 10.0'	475
15						470
20						465
25						460
30						

7 (2-3-4) 28 40
17 (4-7-10)
20 (5-8-12)
(7-19-32) 51

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 7.2' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/6/2010 12:00:53 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-5	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY RQD% — — — REC.% ——— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 472.20

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		
	1	SS	18	12	Clayey SILT, Reddish Brown, Moist, Firm, (ML)	470	⊗ 8 (3-3-5)
							● 23.1
5	2	SS	18	16	Sandy SILT, With Decomposed Rock Fragments, Reddish Brown and Orange, Moist, Firm to Medium Dense, (ML)		⊗ 9 (3-4-5)
							● 21.9
	3	SS	18	16		465	⊗ 10 (3-5-5)
							● 21.6
	4	SS	18	16			⊗ 11 (3-5-6)
10							
						460	
	5	SS	18	18	Silty SAND, With Decomposed Rock Fragments, Reddish Brown, Wet, Medium Dense, (SM)		⊗ 13 (4-6-7)
15					END OF BORING @ 15.0'	455	
20						450	
25						445	
30							

× 33 — △ 48

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 11.8' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRotkowski(1/6/2010 12:06:41 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-6	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% ——— (20% 40% 60% 80% 100%)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 447.27

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		447	
	1	SS	18	6	Sandy SILT, Dark Brown, Wet, Loose, (ML)			5 (2-2-3)
							445	14.3
5	2	SS	18	16	Sandy SILT, Gray and Brown, Moist, Firm to Medium Dense, (ML)			10 (3-4-6)
								6.8
	3	SS	18	14			440	16 (5-7-9)
	4	SS	18	18				13 (4-6-7)
10					END OF BORING @ 10.0'		435	
15							430	
20							425	
25							420	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 7.6' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/6/2010 12:14:40 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-7	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (X — ● — △)

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 430.23

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)
0					Topsoil Depth 7"		
	1	SS	18	10	CLAY, Trace Sand, Gray and Brown, Moist, Soft, (CL)		
	2	SS	18	18	Sandy SILT, With Decomposed Rock Fragments, Grayish Brown, Moist, Firm to Dense, (ML)		425
5	3	SS	18	18			
	4	SS	18	18	Silty SAND, With Decomposed Rock Fragments, Grayish Brown, Moist, Dense, (SM)		420
10							
	5	SS	18	18			
15					END OF BORING @ 15.0'		415
20							410
25							405
30							

5 (2-3-2) 23.2 — 29 — 39 △
8 (2-3-5) 18.8
17 (7-9-8) 13.6
(6-12-20) 32 12.1
(14-15-27) 42

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 8'11" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/6/2010 12:17:02 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-8	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 422.38

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		420	
	1	SS	18	10	Sandy SILT, Dark Brown, Moist, Loose, (ML)			⊗ 5 (4-2-3)
5	2	SS	18	18	Sandy SILT, Trace Decomposed Rock Fragments, Gray and Brown, Moist, Medium Dense, (ML)		415	⊗ 16 (4-7-9)
	3	SS	18	18				⊗ 17 (7-8-9)
	4	SS	18	18				⊗ 29 (6-11-18)
10					END OF BORING @ 10.0'		410	
15							405	
20							400	
25							395	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 5' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/6/2010 12:19:17 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	ROAD-9	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 415.27

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
0						415
	1	SS	18	15		
	2	SS	18	10		
5						410
	3	SS	18	5		
	4	SS	18	5		
10						405
15						400
20						395
25						390
30						

Topsoil Depth 7"

Clayey SILT, With Sand, Trace Rock Fragments, Dark Brown and Black, Moist to Wet, Loose to Firm, (ML-FILL)

END OF BORING @ 10.0'

⊗ 8 (5-3-5) ● 23.0
⊗ 6 (3-3-3) ● 26.3
⊗ 4 (3-2-2) ● 29.0
⊗ 7 (2-3-4)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 5'8" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/6/2010 12:22:39 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMA-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 422.16

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION
0					420	
						Topsoil Depth 6"
	1	SS	18	18		11 (3-4-7)
						Sandy SILT, Yellowish Brown, Moist, Medium Dense to Dense, (ML)
	2	SS	18	18		19 (8-8-11)
5					415	
	3	SS	18	18		25 (10-11-14)
					▽	
	4	SS	18	18		12 (4-4-8)
10					410	
					▽	
	5	SS	18	18		(11-13-21) 34
15					405	
	6	SS	18	18		(8-15-30) 45
20					400	
25	7	SS	18	18		(17-18-21) 39
						Sandy SILT, With Decomposed Rock Fragments, Brown, Wet, Dense, (ML)
					395	
30						END OF BORING @ 26.0'

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL 13.5' WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) 13.5' ▽WL(ACR) 12'9"	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 16'3" @ 24 HRS
▽WL 9'3 @ 24 HRS	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/6/2010 12:24:29 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMA-2	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% —— (20% 40% 60% 80% 100%)

⊗ STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 419.21

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)
0					Topsoil Depth 7"	
	1	SS	18	15	Clayey SILT, Orange, Moist, Firm, (ML)	
	2	SS	18	18	Sandy SILT, Greenish Brown, Moist, Medium Dense to Dense, (ML)	415
5	3	SS	18	18		
	4	SS	17	17	Decomposed Rock, Brown, Moist, Very Dense	410
10						
	5	SS	18	18	Silty SAND, Greenish Brown, Moist, Dense, (SM)	405
15						
	6	SS	11	11	Decomposed Rock, Brown, Moist, Very Dense	400
20						
	7	SS	18	18		395
25						
	8	SS	9	9		390
30						

8 (3-3-5) 26.0

13 (3-5-8) 16.0

10.4

(15-18-22) 40

9.1

(19-29-50/5) 50/5

29 38

(18-21-25) 46

(41-50/3) 50/3

(14-17-18) 35

(39-50/3) 50/3

END OF BORING @ 30.0'

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL 18.5' WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) 18.5' ▽WL(ACR) 16'2"	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 20'3" @ 24 HRS
▽WL 15'5" @ 24 HRS	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:34:07 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMA-3	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY RQD% — — — REC.% 20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 416.03

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 7"	415	
	1	SS	18	18	Sandy SILT, Orange, Moist, Firm to Medium Dense, (ML)		7 (3-3-4)
5	2	SS	18	18		410	14 (6-7-7)
	3	SS	18	18			15 (4-7-8)
							X 29 — △ 47
10	4	SS	18	18	Silty SAND, Trace Clay, Brown, Moist to Wet, Medium Dense to Dense, (SM)	405	13 (5-6-7)
	5	SS	18	18			(10-14-17) 31
15						400	
20	6	SS	18	18		395	(17-18-20) 38
25	7	SS	9	9	Decomposed Rock, Brown, Moist, Very Dense	390	(41-50/3) 50/3
					END OF BORING @ 26.0'		
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL 17.5' WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) 17.5' ▼WL(ACR) 16'	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 17'1" @ 24 HRS
▽WL 15'9" @ 24 HRS	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:38:00 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMA-4	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 417.00

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 4"	415	
	1	SS	18	12	Silty SAND, Brown, Wet, Firm, (SM)		7 (2-3-4)
5	2	SS	18	14	Sandy SILT, Orangish Brown, Moist, Firm to Medium Dense, (ML)	410	8 (3-3-5)
	3	SS	18	16			13 (4-6-7)
	4	SS	18	18			15 (4-6-9)
10						405	
	5	SS	18	18			16 (3-6-10)
15						400	
	6	SS	18	14	Silty SAND, Brown, Wet, Medium Dense, (SM)		23 (6-9-14)
20					END OF BORING @ 20.0'	395	
25						390	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL 16' WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) 16' ▼WL(ACR) 14.3'	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 13' @ 24 HRS
▽WL 12.6" @ 24 HRS	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

Gtotkowski(1/4/2010 11:41:03 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMA-5	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 414.43

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 4"		
	1	SS	18	16	Silty SAND, Orangish Brown to Brown, Moist, Firm to Medium Dense, (SM)		9 (3-4-5)
5	2	SS	18	14		410	14 (5-7-7)
	3	SS	18	16			15 (9-8-7)
	4	SS	18	14		405	17 (5-7-10)
10							
	5	SS	18	14	Sandy SILT, Orange, Moist, Dense, (ML)	400	(9-16-24) 40
15					END OF BORING @ 15.0'		
20						395	
25						390	
30						385	

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 10.9' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:44:51 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMA-6	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 418.75

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		
	1	SS	18	14	SILT, Trace Sand, Dark Brown, Moist, Medium Dense, (ML)		⊗ 11 (3-4-7)
	2	SS	18	12	Sandy SILT, With Quartz, Orangish Brown, Moist, Medium Dense, (ML)	415	⊗ 12 (4-7-5)
5	3	SS	18	14	Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Medium Dense to Dense, (SM)		⊗ 13 (4-6-7)
	4	SS	18	12		410	(8-13-22) ⊗ 35
10							
	5	SS	18	12	Decomposed Rock, Brown, Moist, Very Dense	405	(19-16-53) ⊗ 69
15					END OF BORING @ 15.0'		
						400	
20							
						395	
25							
						390	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 10.3' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:47:37 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMA-7	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 415.26

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 4"	415	
	1	SS	18	12	Sandy SILT, Dark Brown, Moist, Firm, (ML)		9 (3-4-5)
	2	SS	18	14	Sandy SILT, With Decomposed Rock Fragments, Brown, Moist, Medium Dense, (ML)		12 (3-5-7)
5	3	SS	18	16		410	15 (4-6-9)
	4	SS	18	12			24 (5-10-14)
10						405	
	5	SS	18	14	Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Dense, (SM)		(11-20-28) 48
15						400	
					END OF BORING @ 15.0'		
20						395	
25						390	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 11.5' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:50:20 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMB-1	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT–ENGINEER:

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

ECS LLC MID-ATLANTIC

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% ——— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT.: ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 418.15

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		418	
	1	SS	18	14	Sandy SILT, Dark Brown, Moist, Firm, (ML)		415	⊗ 10 (3-4-6)
	2	SS	18	16	Sandy SILT, With Decomposed Rock Fragments, Brown, Moist, Medium Dense, (ML)	10.7		⊗ 15 (4-6-9)
5	3	SS	18	16		6.7		⊗ 20 (5-8-12)
	4	SS	18	18		7.0	410	⊗ 19 (5-8-11)
10								
							405	
	5	SS	18	12	Decomposed Rock, Brown, Moist, Very Dense			(15-27-39) ⊗ 66
15							400	
	6	SS	18	16	Silty SAND, Brown, Moist, Dense, (SM)			(14-23-26) ⊗ 49
20					END OF BORING @ 20.0'		395	
25							390	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 14.5' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:53:39 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMB-2	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY RQD% — — — REC.% 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 419.45

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 4"		
	1	SS	18	16	Silty SAND, Orangish Brown, Moist, Firm, (SM)		⊗ 8 (4-4-4)
	2	SS	18	12	Sandy SILT, Gray and Brown, Moist, Medium Dense, (ML)	415	⊗ 11 (7-5-6)
5	3	SS	18	14			⊗ 13 (4-6-7)
	4	SS	18	12	Silty SAND, With Decomposed Rock Fragments, Brown, Moist, Dense, (SM)	410	(6-13-18) ⊗ 31
10							
	5	SS	18	12	Decomposed Rock, Brown, Moist, Very Dense	405	(14-25-37) ⊗ 62
15					END OF BORING @ 15.0'		
						400	
20							
						395	
25							
						390	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-23-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-23-09	CAVE IN DEPTH @ 11.1' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:56:08 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMC-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 500.54

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
0						500
	1	SS	18	12		
	2	SS	18	14		
5						495
	3	SS	18	16		
	4	SS	18	14		
10						490
	5	SS	18	16		
15						485
20	6	SS	18	16		480
25						475
30						

Topsoil Depth 4"

Sandy SILT, Reddish Brown to Brown, Moist, Loose to Medium Dense, (ML)

END OF BORING @ 21.0'

⊗ 6 (3-3-3) ● 24.7
⊗ 13 (4-6-7) ● 18.4
⊗ 16 (5-7-9)
⊗ 19 (7-9-10)
⊗ 28 (8-13-15)
⊗ 25 (6-11-14)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 15.3' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:59:11 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMC-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 495.15

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION
0					Topsoil Depth 3"		
	1	SS	18	16	SILT, Trace Clay, Orangish Brown, Moist, Loose, (ML)		⊗ 5 (2-3-2)
5	2	SS	18	14	Sandy SILT, With Decomposed Rock Fragments, Reddish Brown, Moist, Loose, (ML)	490	⊗ 6 (3-3-3)
	3	SS	18	16			⊗ 9 (3-4-5)
10	4	SS	18	3	Sandy SILT, With Quartz Gravel, Reddish Brown, Moist, Dense, (ML)	485	(5-9-22) ⊗ 31
15	5	SS	18	16	Sandy SILT, Reddish Brown, Moist, Medium Dense, (ML)	480	⊗ 27 (9-12-15)
					END OF BORING @ 15.0'		
20						475	
25						470	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 11.3' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRotkowski(1/5/2010 12:02:54 AM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMD-1	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY RQD% — — — REC.% ——— 20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 495.53

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0						495	
							Topsoil Depth 5"
	1	SS	18	15			Clayey SILT, Orangish Brown, Moist to Wet, Medium Dense, (ML) — 17 (3-9-8)
	2	SS	18	18			10 (3-4-6)
5						490	Sandy SILT, With Decomposed Rock Fragments, Orange, Brown and Red, Moist, Firm to Dense, (ML) — 29 (4-13-16)
	3	SS	18	18			
	4	SS	18	18			(8-15-27) 42
10						485	
	5	SS	18	18			(14-16-20) 36
15						480	END OF BORING @ 15.0'
20						475	
25						470	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 10'8" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/5/2010 12:05:32 AM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMD-2	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY RQD% — — REC.% 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 491.73

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0						490	
							Topsoil Depth 6"
	1	SS	18	15			9 (3-5-4)
							Clayey SILT, Trace Rock Fragments, Dark Brown, Wet, Firm, (ML)
5	2	SS	18	18		485	7 (3-3-4)
							Sandy SILT, Trace Decomposed Rock Fragments, Brown and Red, Moist, Firm to Dense, (ML)
	3	SS	18	18			17 (8-8-9)
	4	SS	18	10		480	18 (7-8-10)
10							
	5	SS	18	18			(17-18-17) 35
15						475	
							END OF BORING @ 15.0'
20						470	
25						465	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 9'2" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/3/2010 9:31:33 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 518.58

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		518.58	
	1	SS	18	18	SILT, Trace Sand, Reddish Brown to Brown, Moist, Loose to Firm, (ML)			⊗ 6 (2-2-4)
	2	SS	18	18			515	⊗ 9 (3-4-5)
5								
	3	SS	18	18	Sandy SILT, Yellow and Brown, Moist, Medium Dense, (ML)			⊗ 13 (4-6-7)
	4	SS	18	18			510	⊗ 20 (7-9-11)
10								
	5	SS	18	18	Sandy SILT, With Decomposed Rock Fragments, Yellow, Brown and Gray, Moist, Medium Dense, (ML)		505	⊗ 16 (9-8-8)
15								
	6	SS	18	18				⊗ 25 (9-11-14)
					END OF BORING @ 17.0'		500	
20								
							495	
25								
							490	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 8'1"
▽WL	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/3/2010 9:34:14 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 516.59

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION
0					515	
	1	SS	18	15		10 (3-4-6)
	2	SS	18	18		14 (5-6-8)
5					510	
	3	SS	18	18		12 (5-6-6)
	4	SS	18	18		14 (5-7-7)
10					505	
	5	SS	18	18		19 (9-9-10)
15						
	6	SS	18	18	500	15 (5-7-8)
20					495	
25					490	
30						

Topsoil Depth 6"

SILT, Trace Sand and Decomposed Rock Fragments, Brown, Gray and Yellow, Moist, Firm to Medium Dense, (ML)

END OF BORING @ 17.0'

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 11'2" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:30:13 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-3	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY RQD% — — — REC.% ——— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 510.69

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0						510	
							Topsoil Depth 5"
	1	SS	18	18			6 (2-3-3)
							SILT, Trace Clay and Sand, Orangish Brown, Moist, Loose, (ML)
	2	SS	18	18			18 (4-7-11)
5						505	
							Sandy SILT, Trace Decomposed Rock Fragments, Reddish Brown to Black, Moist, Medium Dense to Very Dense, (ML)
	3	SS	18	18			17 (3-6-11)
	4	SS	18	18			(8-20-31) 51
10						500	
	5	SS	18	18			(11-14-21) 35
15						495	
							END OF BORING @ 15.0'
20						490	
25						485	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 9'6" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/3/2010 9:40:23 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-4	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 513.95

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 7"		
	1	SS	18	15	SILT, Trace Sand, Orangish Brown to Gray, Moist, Firm, (ML)		⊗ 7 (3-3-4)
	2	SS	18	18		510	⊗ 8 (3-3-5)
5	3	SS	18	18			⊗ 10 (3-4-6)
	4	SS	18	18	Sandy SILT, With Decomposed Rock Fragments, Brown and Orange, Moist, Medium Dense to Dense, (ML)	505	⊗ 19 (8-8-11)
10							
	5	SS	18	18		500	(11-14-17) ⊗ 31
15					END OF BORING @ 15.0'		
						495	
20							
						490	
25							
						485	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-29-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-29-09	CAVE IN DEPTH @ 7'10"
▽WL	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 10:57:05 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-5	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 514.11

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 7"		
	1	SS	18	18	SILT, Trace Clay, Reddish Brown, Moist, Firm, (ML)		9 (3-4-5)
5	2	SS	18	18	Sandy SILT, With Decomposed Rock Fragments, Red, Brown and White, Moist, Medium Dense, (ML)	510	13 (5-6-7)
	3	SS	18	18			13 (7-6-7)
	4	SS	18	18		505	15 (5-7-8)
10							
	5	SS	10	10	Decomposed Rock, Brown and Red, Moist, Very Dense	500	(21-50/4) 50/4
15	6	SS	11	11			(40-50/3) 50/3
					END OF BORING @ 17.0'		
20						495	
						490	
25							
						485	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 10'2" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 10:59:49 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-6	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY RQD% — — — REC.% 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 510.48

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
0						510
	1	SS	18	18		
5	2	SS	18	18		505
	3	SS	18	18		
10	4	SS	18	18		500
15	5	SS	18	18		495
	6	SS	18	18		
20						490
25						485
30						

Topsoil Depth 6”

Clayey SILT, Trace Rock Fragments, Orangish Brown, Moist, Firm, (ML)

Sandy SILT, With Decomposed Rock Fragments, Red, Brown and Gray, Moist, Medium Dense to Dense, (ML)

END OF BORING @ 19.0’

⊗ 8 (3-4-4) ● 9.6

⊗ 13 (4-6-7) ● 9.6

⊗ 16 (7-6-10)

⊗ 28 (7-11-17)

(11-15-20) ⊗ 35

(15-17-18) ⊗ 35

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 13’2” @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:01:34 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-7	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% — 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 511.11

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 5"	510	
	1	SS	18	15	Clayey SILT, Trace Sand, Dark Reddish Brown, Moist, Firm, (ML)		⊗ 10 (3-5-5)
	2	SS	18	18	Silty SAND, With Decomposed Rock Fragments, Red and Brown, Moist, Medium Dense to Dense, (SM)		⊗ 18 (11-9-9)
5	3	SS	18	18		505	⊗ 12 (4-5-7)
	4	SS	18	18			(8-13-19) ⊗ 32
10						500	
15	5	SS	18	18	SILT, Trace Sand, Yellowish Brown, Moist, Medium Dense, (ML)	495	⊗ 13 (3-5-8)
					END OF BORING @ 16.0'		
20						490	
25						485	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-29-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-29-09	CAVE IN DEPTH @ 7'9"
▽WL	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:04:39 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-8	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▼ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 512.10

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 7"		512	
	1	SS	18	18	Silty SAND, With Decomposed Rock Fragments, Red and Brown, Moist, Medium Dense, (SM)		510	25 (4-6-19)
5	2	SS	18	18				20 (8-9-11) ✕ 29 △ 38
	3	SS	18	18			505	17 (6-7-10)
10	4	SS	18	18	Sandy SILT, Yellowish Brown, Moist, Medium Dense, (ML)		500	29 (8-12-17)
15	5	SS	18	18	Decomposed Rock, Brown, Moist, Very Dense		495	(15-31-35) 66
20	6	SS	18	18	SILT, Trace Sand, Red, Brown and White, Moist, Medium Dense, (ML)		490	28 (7-12-16)
					END OF BORING @ 20.0'		485	
25								
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 13'11"
▽WL	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:07:05 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-9	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% — 20% — 40% — 60% — 80% — 100%

STANDARD PENETRATION BLOWS/FT.: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 508.07

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 7"		
	1	SS	18	18	Sandy SILT, With Decomposed Rock Fragments, Red, Brown and Orange, Moist, Medium Dense, (ML)	505	6.8 ● 14 (2-4-10)
5	2	SS	18	18			7.3 ● 15 (5-6-9)
	3	SS	18	18			23 (10-11-12)
	4	SS	18	18	SILT, Orange and Gray, Moist, Medium Dense, (ML)	500	16 (6-7-9)
10							
	5	SS	18	18	Sandy SILT, With Decomposed Rock Fragments, Brown, Moist, Dense, (ML)	495	(11-20-25) 45
15							
	6	SS	18	18	Decomposed Rock, Brown and Gray, Moist, Very Dense	490	(19-35-47) 82
20					END OF BORING @ 20.0'		
						485	
25							
						480	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▽WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 13'11" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:10:18 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-10	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 506.71

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
0						505
	1	SS	18	8		
	2	SS	18	18		500
5	3	SS	18	18		
	4	SS	18	18		495
10						
	5	SS	5	5		490
15						
20						485
25						480
30						

Topsoil Depth 6"

Sandy SILT, With Decomposed Rock Fragments, Reddish Brown, Moist, Firm to Medium Dense, (ML)

Decomposed Rock, Reddish Brown, Moist, Very Dense

END OF BORING @ 13.9'

⊗ 7 (3-3-4)
⊗ 11 (3-5-6)
⊗ 10 (5-5-5)
⊗ 12 (3-4-8)
(50/5) ⊗ 50/5

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 10.0' @ EOD
▽WL DRY @ EOD	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/3/2010 9:37:52 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-11	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 507.66

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
0						505
	1	SS	18	12		
	2	SS	18	18		
5						500
	3	SS	18	18		
	4	SS	18	18		
10						495
	5	SS	10	10		
15						490
	6	SS	2	2		
20						485
25						480
30						

Topsoil Depth 6"

Sandy SILT, With Decomposed Rock, Red, Gray and Brown, Moist, Firm to Medium Dense, (ML)

Decomposed Rock, Red and Brown, Moist, Very Dense

END OF BORING @ 20.0'

10 (3-4-6)
27 (14-14-13)
8 (3-4-4)
(8-16-21) 37
(46-50/4) 50/4
(50/2) 50/2

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 14'2" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:16:39 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWME-12	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 501.82

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		501.82	
	1	SS	18	15	SILT, Trace Sand, Reddish Brown, Moist, Firm to Medium Dense, (ML)		500	⊗ 7 (2-3-4)
5	2	SS	18	18				⊗ 13 (5-5-8)
	3	SS	18	18			495	⊗ 16 (5-8-8)
	4	SS	18	18	Sandy SILT, Yellowish Brown, Moist, Medium Dense, (ML)			⊗ 15 (5-7-8)
10							490	
	5	SS	18	18				⊗ 21 (7-11-10)
15					END OF BORING @ 15.0'		485	
20							480	
25							475	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 9' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:27:45 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMF-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▼ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 502.32

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 4"		502	
	1	SS	18	12	Clayey SILT, Orangish Brown, Moist, Firm, (ML)			⊗ 9 (3-4-5)
								● 10.9
	2	SS	18	14	Sandy SILT, With Decomposed Rock Fragments, Orangish Brown, Moist, Loose to Medium Dense, (ML)		500	⊗ 6 (2-3-3)
5								● 10.4
	3	SS	18	16				⊗ 13 (4-6-7)
							495	
					Silty SAND, With Decomposed Rock Fragments, Brown and Gray, Moist, Medium Dense, (SM)			
10								
							490	
	4	SS	18	12				⊗ 16 (5-7-9)
15								
	5	SS	18	14	Sandy SILT, Reddish Brown, Moist, Medium Dense, (ML)		485	⊗ 22 (6-9-13)
					END OF BORING @ 18.0'			
20							480	
25							475	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-29-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-29-09	CAVE IN DEPTH @ 13.1' @ 24 HRS
▽WL DRY @ EOD	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/4/2010 11:13:39 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMF-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 500.57

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0						500	
							Topsoil Depth 4"
	1	SS	18	10			7 (2-3-4)
							Clayey SILT, Dark Brown, Moist, Firm, (ML)
	2	SS	18	14			8 (3-3-5)
5						495	Sandy SILT, Trace Decomposed Rock Fragments, Reddish Brown, Moist, Firm to Medium Dense, (ML)
	3	SS	18	16			16 (5-7-9)
	4	SS	18	12			21 (5-9-12)
10						490	
	5	SS	18	16			18 (5-8-10)
15						485	END OF BORING @ 15.0'
20						480	
25						475	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-29-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-29-09	CAVE IN DEPTH @ 11.6' @ 24 HRS
▽WL DRY @ EOD	RIG CME750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/5/2010 3:47:39 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	SWMG-1	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % (X) — WATER CONTENT % (●) — LIQUID LIMIT % (Δ)

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% — 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (⊗) 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 547.00

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION
0					547	
						Topsoil Depth 6"
	1	SS	18	10	545	6 (3-3-3)
						Sandy SILT, With Decomposed Rock Fragments, Orangish Brown, Moist, Firm, (ML)
5	2	SS	18	18		8 (3-3-5)
					540	
	3	SS	18	18		9 (4-4-5)
						Sandy SILT, With Decomposed Fragments, Reddish Brown, Moist, Firm to Dense, (ML)
	4	SS	18	18		16 (6-7-9)
10					535	
						(19-20-40) 60
	5	SS	18	18		
15						END OF BORING @ 15.0'
					530	
20						
					525	
25						
					520	
30						

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-29-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-29-09	CAVE IN DEPTH @ 7'6"
▽WL	RIG CME750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/5/2010 3:51:43 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 573.26

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 2"		573	
	1	SS	18	12	Clayey SILT, With Decomposed Rock Fragments, Brown and Red, Moist, Loose, (ML-FILL)			⊗ 5 (4-3-2)
								● 26.2
	2	SS	18	16	SILT, Red, Moist, Firm to Medium Dense, (ML)		570	⊗ 7 (2-3-4)
5								● 32.5
								✕ 31 △ 40
	3	SS	18	16				⊗ 17 (4-6-11)
								● 25.4
	4	SS	5	5	Decomposed Rock, Gray, Moist, Very Dense		565	(50/5) ⊗ 50/5
10								● 8.8
	5	SS	0	0	AUGER REFUSAL @ 13.0'		560	(50/0) ⊗ 50/0
15							555	
20							550	
25							545	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-29-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-29-09	CAVE IN DEPTH @ 10.8'
▽WL	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

JMcGregor(1/5/2010 3:54:34 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-2	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)

PLASTIC LIMIT % X — WATER CONTENT % — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY RQD% — — — REC.% (20% 40% 60% 80% 100%)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 558.97

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)
0					Topsoil Depth 4"	
	1	SS	18	10	Sandy SILT, With Decomposed Rock Fragments, Dark Brown, Moist, Loose, (ML)	
	2	SS	18	14	Sandy SILT, With Decomposed Rock Fragments, Red and Brown, Moist, Medium Dense, (ML)	555
5	3	SS	18	12	Silty SAND, With Decomposed Rock, Brown, Moist, Medium Dense, (SM)	
	4	SS	18	8		550
10						
	5	SS	18	16	Sandy SILT, Trace Decomposed Rock Fragments, Orange and Brown, Moist, Medium Dense to Dense, (ML)	545
15						
	6	SS	18	14		540
20					END OF BORING @ 20.0'	
25						535
30						530

5 (3-3-2) 16.5 — 12 (3-5-7) 9.9 — 29 (12-15-14) 4.0 — 17 (9-10-7) 21.6 — 20 (6-9-11) 23.5 — (8-13-19) 32 17.7

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 15.8'
▽WL	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

JMcGregor(1/3/2010 9:05:55 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 551.50

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
0						550
	1	SS	18	10		
5	2	SS	18	12		545
	3	SS	18	14		
10	4	SS	18	14		540
	5	SS	18	16		535
15						
20	6	SS	18	16		530
25						525
30						

Silty CLAY, With Organics, Gravel and Asphalt Fragments, Brown to Black, Moist to Wet, Soft, (CL-FILL)

CLAY, With Decomposed Rock Fragments, Orangish Brown, Moist, Medium Stiff to Stiff, (CL)

Sandy SILT, With Decomposed Rock Fragments, Light to Dark Brown, Moist, Medium Dense, (ML)

END OF BORING @ 20.0'

5 (3-3-2) 13.6
6 (2-3-3) 20.1
11 (3-5-6) 22.0
11 (3-5-6) 19.0
13.1
28 (9-13-15)
14.8
23 (10-11-12)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 16.0'
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

JMcGregor(12/28/2009 5:02:10 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-4	1 OF 1

PROJECT NAME: Montgomery College Bioscience

ARCHITECT-ENGINEER:

ECS LLC MID-ATLANTIC

SITE LOCATION: Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% ——— (20%, 40%, 60%, 80%, 100%)

STANDARD PENETRATION BLOWS/FT. ⊗ (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 537.04

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 2"	535	6 (2-3-3)
	1	SS	18	10	Sandy SILT, With Decomposed Rock Fragments, Brown, Moist, Loose to Medium Dense, (ML-FILL)		19.8
5	2	SS	18	12			10 (3-4-6)
							18.6
	3	SS	18	16		530	12 (5-7-5)
							21.1
	4	SS	18	10	Sandy SILT, With Decomposed Rock Fragments, Decomposed Wood Layer at 8.5', Gray and Black, Wet, Loose, (ML-FILL)		5 (3-2-3)
10							57.5
						525	
	5	SS	18	12	Clayey SILT, Orangish Brown, Moist, Stiff, (ML)		13 (4-6-7)
15							27.3
						520	
	6	SS	18	14	Silty SAND, With Decomposed Rock, Gray and Brown, Moist, Dense, (SM)		(8-15-22) 37
20							7.2
					END OF BORING @ 20.0'	515	
25							
						510	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 15.5 @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

JMcGregor(12/28/2009 5:07:11 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-5	1 OF 1
PROJECT NAME	ARCHITECT-ENGINEER		
Montgomery College Bioscience			

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 510.93

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)
0						510
	1	SS	18	12		
	2	SS	18	16		
5						505
	3	SS	18	14		
	4	SS	18	18		
10						500
	5	SS	18	16		
15						495
	6	SS	18	18		
20						490
25						485
30						

Topsoil Depth 2"

SILT, Trace CLAY and Decomposed Rock Fragments, Dark Brown, Moist to Wet, Loose to Firm, (ML-FILL)

Sandy SILT, With Decomposed Rock Fragments, Brown, Moist, Medium Dense, (ML)

END OF BORING @ 20.0'

⊗ 5 (3-2-3) ● 18.0
⊗ 6 (2-3-3) ● 28.7 × 29 — △ 41
⊗ 10 (3-4-6) ● 20.4
⊗ 20 (5-8-12) ● 9.0
● 14.1
⊗ 15 (4-8-7)
● 23.5
⊗ 19 (5-8-11)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 15.7' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

JMcGregor(12/28/2009 5:15:43 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-6	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)
PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △
ROCK QUALITY DESIGNATION & RECOVERY RQD% — — — REC.% (20% 40% 60% 80% 100%)
STANDARD PENETRATION BLOWS/FT. ⊗ (10 20 30 40 50+)

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 499.07

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.	WATER CONTENT %	LIQUID LIMIT %
0					Topsoil Depth 4"				
	1	SS	18	12	Silty CLAY, Orange to Brown, Moist, Medium Stiff, (CL-FILL)		7 (3-3-4)	30.1	
	2	SS	18	12		495	10 (3-4-6)	30	43
5					Sandy SILT, With Decomposed Rock Fragments, Orange, Brown, Gray and Red, Moist, Medium Dense to Dense, (ML)			23.4	
	3	SS	18	14			14 (5-6-8)	19.5	
	4	SS	18	16		490	29 (6-11-18)	15.2	
10									
	5	SS	18	18		485	(11-13-20) 33	11.1	
15									
	6	SS	18	12	Decomposed Rock, Brown, Gray and Red, Moist, Very Dense	480	(14-23-39) 62	7.3	
20					END OF BORING @ 20.0'				
25						475			
30						470			

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 16.9' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

JMcGregor(12/28/2009 5:22:31 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-7	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 479.04

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		
	1	SS	18	18	SILT, Trace CLAY, Orangish Brown, Moist to Wet, Firm, (ML)		⊗ 7 (2-3-4) ● 28.0
5	2	SS	18	18	Silty SAND, With Decomposed Rock Fragments, Reddish Brown, Moist, Medium Dense to Dense, (SM)	475	⊗ 12 (4-4-8) ● 9.7
	3	SS	18	18			● 10.7 (12-12-18) ⊗ 30
	4	SS	18	18		470	● 16.5 (12-20-25) ⊗ 45
10							
15	5	SS	18	18	Sandy SILT, Brown, Gray and Red, Moist, Medium Dense to Dense, (ML)	465	● 11.1 (17-18-20) ⊗ 38
	6	SS	18	18		460	● 24.5 (6-13-17) ⊗ 30
20					END OF BORING @ 20.0'		
25						455	
30						450	

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 13.1' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(12/28/2009 5:26:18 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-8	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 493.0

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					490	
	1	SS	18	18		⊗ 8 (3-3-5)
						● 24.5
	2	SS	18	18		⊗ 15 (6-6-9)
5						● 15.2
	3	SS	18	10	485	⊗ 14 (7-7-7)
						● 12.3
	4	SS	18	15		⊗ 17 (5-8-9)
10						● 10.6
					480	
	5	SS	18	15		⊗ 15 (6-7-8)
15						
					475	
	6	SS	18	18		(9-13-17) ⊗ 30
20						
					470	
25						
					465	
30						

Topsoil Depth 7"

SILT, Trace Sand and Decomposed Rock Fragments, Gray and Red, Moist, Firm to Medium Dense, (ML)

Sandy SILT, With Decomposed Rock Fragments, Brown and Red, Moist, Medium Dense, (ML)

END OF BORING @ 20.0'

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-24-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-24-09	CAVE IN DEPTH @ 13'4" @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN T.C.	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(1/3/2010 8:45:46 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-9	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — REC.% (20% 40% 60% 80% 100%)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 493.84

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 3"			
	1	SS	18	14	SILT, Trace Clay, Dark Brown, Moist, Loose, (ML-FILL)			6 (2-3-3)
							490	22.7 ● × 28 — △ 39
5	2	SS	18	14	SILT, Reddish Brown, Moist, Firm, (ML)			7 (2-3-4)
								21.5 ●
	3	SS	18	16				8 (3-3-5)
							485	25.2 ●
10	4	SS	18	16	Sandy SILT, With Decomposed Rock Fragments, Brown, Red and Gray, Moist, Medium Dense to Dense, (ML)			16 (4-7-9)
								16.5 ●
	5	SS	18	14			480	(7-15-23) 38
15								10.7 ●
	6	SS	18	12				(10-19-29) 48
								5.3 ●
					END OF BORING @ 17.0'		475	
20								
							470	
25								
							465	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-29-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-29-09	CAVE IN DEPTH @ 12.2' @ 24 HRS
▽WL DRY @ EOD	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRotkowski(1/3/2010 8:54:18 PM)

CLIENT	JOB #	BORING #	SHEET
The Lukmire Partnership	3921	WSSC-10	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montgomery College Bioscience	

ECS LLC MID-ATLANTIC

SITE LOCATION
Observation Drive, Germantown, Maryland

SWM and Road Borings

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 479.00

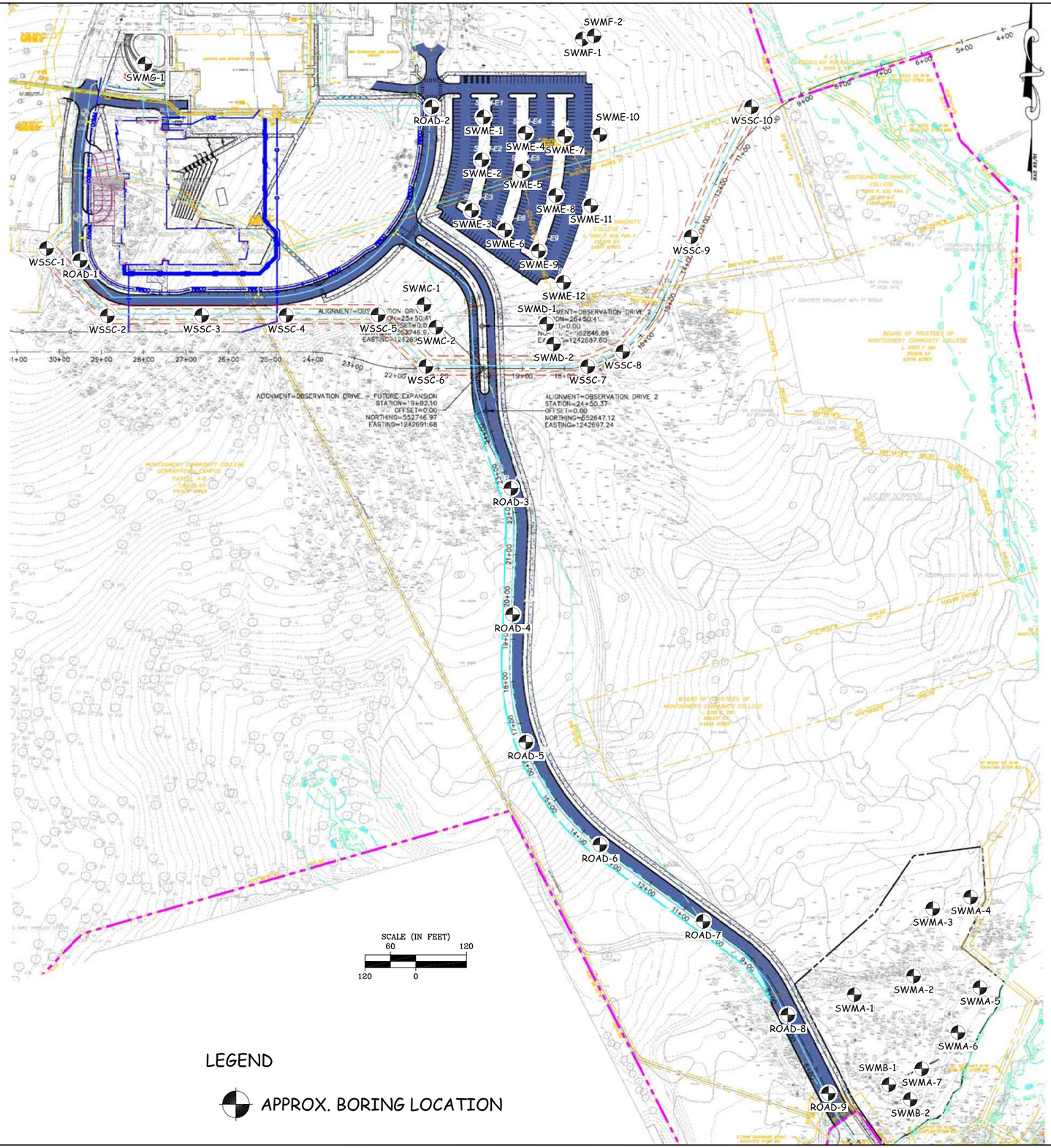
DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 3"			
	1	SS	18	14	Sandy SILT, With Decomposed Rock Fragments, Brown and Red, Moist, Firm, (ML)			⊗ 9 (3-4-5)
								● 12.7
	2	SS	18	12	Clayey SILT, With Decomposed Rock Fragments, Reddish Brown, Moist, Medium Dense, (ML)		475	⊗ 12 (4-6-6)
5								● 16.6
	3	SS	18	14				⊗ 13 (4-5-8)
								● 27.0
	4	SS	18	16	Sandy SILT, With Decomposed Rock Fragments, Orange and Brown, Moist, Medium Dense, (ML)		470	⊗ 19 (5-8-11)
10								● 19.1
	5	SS	18	18			465	● 16.3 ⊗ 26 (6-11-15)
15								
	6	SS	18	16			460	● 18.8 ⊗ 28 (7-12-16)
20					END OF BORING @ 20.0'			
							455	
25								
							450	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL DRY WS OR WD	BORING STARTED 12-28-09	
▽WL(BCR) DRY ▼WL(ACR) DRY	BORING COMPLETED 12-28-09	CAVE IN DEPTH @ 15.7' @ 24 HRS
▽WL DRY @ 24 HRS	RIG CME 750 FOREMAN PRICE	DRILLING METHOD HSA

AMH (02-25-10) AMH (03-30-10) AMH (03-31-10)

GRatkowski(12/28/2009 4:50:58 PM)



ECS - MID-ATLANTIC LLC
5012 Monument Avenue, Suite 15
Frederick, MD 21704
TEL (301) 668-4303
FAX (301) 668-3519

CELEBRATING OVER 20 YEARS OF EXCELLENCE

SETTING THE STANDARD FOR SERVICE

ECS LLC MID-ATLANTIC

MONTGOMERY COLLEGE BIOSCIENCE
SWM AND ROAD BORINGS
MONTGOMERY COUNTY

BORING LOCATION DIAGRAM
THE LUKEMIRE PARTNERSHIP

ECS REVISIONS

ENGINEER	DRAFTING
JAM	AMH

SCALE	1" = 120'
PROJECT NO.	13-3921
SHEET	1 OF 1
DATE	03-09-10

SECTION 021300 - AGGREGATE PIERS

PART 1 - GENERAL

1.1 STANDARDS AND REFERENCES

A. The most recent version of the following testing methods may be employed:
   1. Spread Footing Load Testing (individual column, or column groups) D1194 modified for size.
   2. Standard Test Method for Piles Under Static Axial Compressive Load ASTM D1143
   3. Standard Test Method for Individual Piles Under Static Axial Tensile Load ASTM D3689

B. Reference documents as provided to the aggregate pier contractor shall include:
   1. This specification.
   2. Project geotechnical report.
   3. Contract documents.

1.2 SCOPE OF WORK

A. The work shall consist of installation, monitoring and testing of the aggregate piers within the limits indicated on the Contract Documents to meet the performance criteria presented in 3.3 of this specification.

B. The aggregate pier contractor shall provide all labor, materials, and equipment to accomplish the following items of work:
   1. Pre-drilling of holes as necessary and disposal or stockpiling of all spoil.
   2. Construction of the aggregate piers to the lines and grades on the construction drawing.

C. It shall be the aggregate pier contractor's responsibility to determine and implement the systems and criteria to ensure that the specified performance is achieved.

1.6 SUBMITTALS

A. The following shall be submitted to the Owner's representative by the aggregate pier contractor with the bid documents:
   1. A list of at least five previously completed projects of similar scope and purpose for approval by the Owner's representative. The list shall include a description of the project, relative size, and contact person with phone number.

B. The following shall be submitted to the Owner's representative by the aggregate pier contractor two weeks prior to the start of the work:
   1. Resumes of the management, supervisory, and key personnel.
   2. A ground improvement design based on information contained in the project geotechnical report, prepared by an engineer licensed in the State of Maryland that demonstrates that the program achieves the specified performances criteria as specified in 3.3.
   3. A ground improvement QA plan, as detailed in 3.4.
   4. Work procedures and control criteria.
   5. A shop drawing for review, indicating the spacing, location, and depth of the aggregate piers to achieve the criteria outlined in this specification.
   6. Modulus test detail and setup to confirm that the installation procedure produces the pier modulus used in the design.

C. The following shall be submitted to the Owner's representative by the aggregate pier contractor during the work:
   1. Accurate daily records that include the type and size of compaction equipment and predrill auger diameter used, and, for each aggregate pier, the identification number and depth of the pier tip.
   2. Any change in the subsurface conditions observed during the work.
   3. The modulus test data, analysis of the data, and the concluding recommended design parameters, prepared by an engineer licensed in the State of Maryland.

D. The following shall be submitted to the Owner's representative by the aggregate pier contractor after the work is completed:
   1. A report documenting the observations and results of the tests. This report will certify that the bearing pressure has been achieved within settlement tolerances.
   2. A warranty document good for one year.

1.7 QUALIFIED CONTRACTORS

The aggregate pier contractor shall meet the requirements stated in the following section.

1.8 QUALITY ASSURANCE

A. The aggregate pier program shall be performed by a specialist aggregate pier contractor with at least five continuous years of documented experience in aggregate piers.

B. The aggregate pier contractor shall provide experienced management, supervisory and key personnel to implement the aggregate pier program.

C. As detailed in 1.6, the aggregate pier contractor shall provide evidence of aggregate pier project experience.

D. The Owner's representative will ensure that procedures and documentation conform to these specifications.

PART 2 - EQUIPMENT AND MATERIALS

2.1 EQUIPMENT

A. Down-Hole Vibrator
   1. Should the aggregate pier contractor use a down-hole vibrator, the vibrator shall be capable of providing at least 80 HP of rated energy and a centrifugal force of 15 tons. An appropriate metering device should be provided at such a location that inspection of amperage increase may be verified during the operation of the equipment. The metering device may be an ammeter directly indicating the performance of the vibrator tip. Complete equipment specifications should be submitted to the Engineer prior to commencement of the fieldwork.

B. Down-Hole Tamper
   1. Should the aggregate pier contractor use a down-hole tamper, the tamper shall have a diameter that is at least 90% of the pre-drilled hole diameter, have beveled sides, and be long enough to reach the full depth of the pre-drilled hole. The tamper shall have a minimum Construction Industry Manufacturer's Association (CIMA) rating of 1,225 ft-lb and shall apply direct downward impact energy to each lift of aggregate. A minimum tamper energy level of 490,000 ft-lbs of force per minute shall be applied by the energy source.

2.2 BACKFILL MATERIALS

A. Down-Hole Vibrator Method: The backfill aggregate should consist of hard, angular to sub-angular durable rock fragments, with the majority of particles in the range of 1/8th inch to 1-1/2 inches such as ASTM C33 size No. 57, or shall be other graded aggregate selected by the installer and successfully used in the modulus test.

B. Down-Hole Tamper Method:
   1. Aggregate used for piers constructed above the water table shall be Type I, Grade B in accordance with ASTM D1241, or shall be other graded aggregate selected by the installer and successfully used in the modulus test.
   2. For aggregate used for piers constructed below the water table, the gradation shall be the same as Type I Grade B, except that particles passing the number 40 sieve shall be eliminated. Alternately, No. 57 stone or other stone selected by the installer may be used.
   3. When type I Grade B material is used, potable water or other suitable source shall be used to increase the aggregate moisture content when required.

PART 3 - EXECUTION

3.1 SITE INSPECTION

A. If an adjacent building is within 15 ft of the aggregate pier work area, a relevant building examination shall be performed prior to initiating work to document preexisting cracks/damage. The building must also be monitored for movement during any work within 15 ft of the structure. The work shall be stopped and the engineer notified if any building settlement is observed.

B. The Contractor shall familiarize himself with the site plan and be aware of all above and below ground utilities and obstructions, any environmental restrictions, work boundaries and hours for construction.

3.2 AGGREGATE PIER CONSTRUCTION

The general procedures are as follows:

A. Stable Ground Conditions: The following general procedures shall be followed when the pre-drilled hole remains open during construction.
   1. Pre-drilling to the design depth will be performed with an auger diameter equal to the finished column diameter.
   2. Down-Hole Vibrator Method: The quantity of aggregate initially added shall be such that the vibrator tip is able to penetrate to within 12 inches of the design depth. The vibrator will be raised and lowered repeatedly, such that on each re-penetration, the tip of the vibrator advances to within 12 inches of the previous penetration depth.
   3. Down-Hole Tamper Method: Following placement of the first 12-inch lift of aggregate, the tamper is to be lowered to the top of the aggregate and activated. The full energy of the impactor and weight of the excavator shall be used for at least 30 seconds per lift, and subsequent lifts shall not exceed 12 inches in thickness.
   4. The aggregate shall be removed and replaced with fresh aggregate if cave-ins occur during the aggregate placement such that the volume of caved-in soil is greater than 10 percent of the aggregate being compacted.

B. Unstable Ground Conditions: The following general procedures will be followed when a pre-drilled hole will not remain open before or during pier construction.
   1. Down-Hole Vibrator Method: If the hole will remain temporarily stable, the hole may be

filled with aggregate to a level above the instability as long as the vibrator is still able to penetrate to within 1 foot of the pre-drilled depth. If the hole will not remain temporarily stable, a Bottom Feed Down-Hole vibrator may be used.

2. Down-Hole Tamper Method: A casing with a minimum outside diameter equal to 100% of the pier diameter is advanced to the full treatment depth. The first 12-inch lift of aggregate will be placed, and the tamper lowered to the top of the aggregate. The full energy of the impactor and weight of the excavator shall be used for at least 30 seconds per lift, and subsequent lifts shall not exceed 12 inches in thickness. The casing is extracted after each lift is compacted with the bottom of the casing always maintained below the top of the aggregate.

C. Obstructions: Aggregate piers shall be constructed within 6 inches of the design location. Obstructions encountered during excavation or drilling that will prevent installation of the aggregate piers to design depth, or cause the aggregate pier to stray from its specified location during installation shall be removed. To the extent the obstructions are shown in the geotechnical report, removal of obstructions shall be performed at no additional cost to the owner.

Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., that prevent installing the aggregate piers to the required depth, or cause the aggregate pier to drift from the required locations. Dense natural rock or weathered rock shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials. The aggregate pier design engineer shall be notified within 24 hours to verify that the short piers are acceptable.

3.3 PERFORMANCE CRITERIA

A. Construct appropriate aggregate piers with granular backfill material beneath all column foundations and load-bearing wall foundations to provide the following criteria upon completion:
1. An allowable soil bearing capacity of 6,000 pounds per square foot (psf) with a maximum total settlement of 1/4" inches and a maximum differential settlement of 0.003 times the distance between adjacent columns.

B. Aggregate piers should be constructed to a depth sufficient to satisfy the settlement criteria above. A modulus test shall be performed to verify the parameter values selected for the pier aggregate.

3.4 FIELD QUALITY ASSURANCE

A. Inspections
1. All aggregate pier operations shall be performed under the observation and documentation of the Field Quality Control Representative (FQCR).
2. Monitoring and logging of aggregate pier operations for both test and production work shall be done by the FQCR.
3. The FQCR will provide site observation and documentation to ensure performance of the aggregate pier work. This inspection may include the following: recording of predrill hole depth, observance of the aggregate pier contractor's procedures, and recording of compaction energy information.
4. A sample of the backfill material should be submitted to the Engineer for a grain size distribution analysis to establish the suitability, the cost of which will be borne by the owner. Certification of grain size distribution provided by the quarry may be submitted in lieu of a sample.
5. The foundation bearing surface shall be compacted and firm prior to the construction of the foundation.

B. Modulus Test

Testing to determine specification compliance will be provided by the aggregate pier contractor, and

will consist of at least one modulus test of an aggregate pier.

The results of the Modulus Test shall meet the following criteria to pass:

1. The geotechnical engineer shall approve of the location of the Modulus Test.
2. Deflections of the top of the test pier shall be measured by a suitable method.
3. Deflections at the bottom of the test pier shall be measured by means of a telltale installed at the bottom of the test aggregate pier. Performance will be deemed acceptable when, at the specified design stress, deflection at the bottom of the pier does not exceed 20% of the deflection at the top of the pier.
4. Load increments, decrements, and duration, shall be determined using ASTM D1143 as general guidelines.
5. Surficial disturbance shall be compensated for by applying a seating load equal to 5% of the total load to the loaded steel plate before applying load increments.
6. The modulus testing shall be performed as described in the Design Submittal.

3.5 Uplift Test

A. In addition to specifications within this section, ASTM D3689 shall be the general guide in establishing uplift load test procedures. The uplift load test will be performed as described in the Design Submittal.

B. The Geotechnical Engineer shall approve the site location of the uplift load test.

C. Verification that the design of the aggregate pier system is in accordance with the performance observed during the uplift load test shall be attained through information acquired during the uplift load test.

3.6 Rejection of Aggregate Piers

A. If an aggregate pier is installed in an incorrect location or exceeds the specified tolerances, the aggregate pier contractor shall replace the pier. Pier replacement may be avoided if alternate remedial procedures are approved by the Engineer. Unless the rejection is caused by obstruction, refusal in rock or dense soil or errors in the project drawings, the cost of all labor and material required for the replacement shall not be the responsibility of the Owner.

3.7 Excavation of Pier Tops, and Utilities

A. Excavations conducted after aggregate pier installation shall be performed such that the horizontal distance between the edge of any aggregate pier and the nearest edge of the excavation is such that the pier is not affected. If installed aggregate piers are located within the zone of influence of excavation, the General Contractor and Engineer shall collaborate to develop solutions to excavation or construction methods that will avoid detrimental impact to the installed aggregate piers.

Potential solutions include:

1. Constructing affected portions of the aggregate piers with a cement-treated aggregate.

2. Placing and compacting select aggregate in excavation zones that have disrupted the structural continuity of the aggregate pier. Operations, materials, equipment, and testing shall adhere to the following requirements:
   a. Gradation of the aggregate shall meet specifications drafted by the Engineer.
   b. The impact compaction equipment shall be motorized and the procedure shall ensure controlled placement of the aggregate.
   c. Compaction of the aggregate shall reach 95% of the maximum dry density. The

maximum dry density shall be determined by the modified Proctor method (ASTM D1557).

d. Placement and compaction shall be observed on-site by personnel from an independent testing firm. The independent testing firm shall also execute density testing on-site, and submit results of the density testing to the General Contractor and Engineer. Scheduling of excavation, placement, and compaction shall be determined by the General Contractor. The General Contractor will provide the aforementioned schedule to the independent testing firm and make arrangements for observation of placement and compaction, and execution of density testing.

3.8 Bottoms of Footings

A. Prior to placement of structural concrete, aggregate pier tops shall be excavated in a manner that will prevent the soil matrix surrounding the aggregate piers from softening, and ensure that a direct connection between the aggregate pier and concrete footing will be achieved.

B. The following excavation procedures shall be followed:

1. Over-excavation below the bottom of the footing shall be backfilled with the material and procedures described in 3.7A.2.
2. Aggregate pier tops and footing bearing soils shall be compacted with a motorized impact compactor. Tampers of the "sled" variety shall not be employed. The entire surface area of the footing bottom shall be compacted to ensure that any loose surface soil and/or loose surface aggregate is densified.
3. Footing concrete shall be placed immediately following approval of the completed footing excavation work. It is ideal that approval of the excavation work be stated on the same day that the excavation takes place. If the bearing soils are expansive or sensitive, it is imperative that the footing concrete be placed on the same day that the excavation takes place.
4. If footing concrete cannot be placed on the same day that excavation takes place, a minimum 3-inch thick mud mat shall be placed immediately following approval of the footing excavation.

C. The following criteria shall apply, and shall be verified by the FQCR in a written report:

1. The footing excavation has been kept free of water since completion of excavation work. This will ensure that the unconfined matrix soil surrounding the aggregate piers has not been softened. Softening of the matrix soil may negatively impact the load bearing capability of the reinforced subgrade.
2. That at each footing location, all aggregate piers installed have been fully exposed within the limits of the footing excavation.
3. That the following specified procedures required immediately prior to construction of the footings have been followed:
   a. Inspection of each aggregate pier top after exposure by the footing excavation.
   b. Recompaction, as required, of aggregate pier tops by mechanical impact compaction equipment.
   c. Recompaction of aggregate pier tops that have or may have been disturbed by footing excavation or other actions, to the satisfaction of the FQCR.
4. Assurance that no excavation has been made within a distance that will affect any completed pier, without being approved in writing by the aggregate pier contractor and Engineer.

3.9 FOOTING SUBGRADE PREPARATION

A. The footing bearing surface shall be free of all water and compacted prior to placement of any reinforcement. Compaction can be by any heavy tamping type compaction equipment designed for compaction in small spaces. Reinforcement and concrete placement shall be placed in a timely manner

so that no degradation of the bearing surface occurs.

END OF SECTION

SECTION 033000- CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
   1. Footings.
   2. Foundation walls.
   3. Slabs-on-grade.
   4. Suspended slabs.
   5. Slabs on steel deck.
   6. Concrete toppings.
   7. Building frame members.
   8. Building walls.

B. Related Sections include the following:

   1. Division 2 Section 023000 “Earthwork”.
   2. Division 5 Section 051200 “Structural Steel”

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.

E. Samples:
1. Waterstops.
2. Mechanical splices.
3. Vapor retarder.
4. Color additive manufacturer's color chart or sample chip set for color selection.
5. Sample chips of specified colors indicating additive numbers and required dosage rates.

F. Welding certificates.

G. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

2. Gradation of aggregates.

H. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds and evaporation retarders.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Joint-filler strips.
13. Repair materials.
14. Coloring additives.

I. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.

J. Field quality-control test and inspection reports, submitted to the Architect, Construction Manager and Structural Engineer directly from the independent inspection agency hired by the Owner.

K. Minutes of pre-installation conference.

L. LEED Submittals:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   a. Include statement indicating costs for each product having recycled content.
2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.

3. Credit EQ 4.2: Product data for curing and sealing compounds used inside the weatherproofing system indicating chemical composition and VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, employed by the Owner, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete,"
2. ACI 318, “Building Code Requirements for Structural Concrete,”
3. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
4. ACI 315, "Manual of Standard Practice for Detailing Concrete Structures".
5. ACI 305, “Hot Weather Concreting”.
6. ACI 306, “Cold Weather Concreting”.
7. ACI 336.1, “Design and Construction of End Bearing Drilled Piers”.
8. AWS D1.4, “Structural Welding Code – Reinforcing Steel”.

G. Concrete Mix Design Service: Engage a qualified independent entity qualified to perform material evaluation tests and to design concrete mixtures.

H. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent entity responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete subcontractor.
    e. Testing agency.
    f. Architect.
    g. Structural Engineer of Record.
    h. Owner’s representative.

2. Review special inspection and testing and inspecting agency procedures for field quality control, hot-weather concreting procedures, cold weather protection, curing procedures, construction joints, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

C. Additives and Admixtures: Comply with manufacturer’s instructions. Deliver to batch plant in original, unopened packaging. Store in dry conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.

2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

   a. High-density overlay, Class 1 or better.
   b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
   c. Structural 1, B-B or better; mill oiled and edge sealed.
   d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed, for welded applications.

C. Plain-Steel Wire: ASTM A 82.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. Do not use rocks, bricks, blocks, site debris etc. for reinforcing support.

2.5 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I or II.
   Limited use of the following as replacement cementitious materials per specifications:

   a. Fly Ash: ASTM C 618, Class C
   b. Ground Granulated Blast-Furnace Slag (GGFB): ASTM C 989, Grade 100 or 120.
   c. Pozzolans are not permitted for use in colored concrete.

B. Normal-Weight Aggregates: ASTM C 33. Provide all aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Lightweight Aggregate: ASTM C 330, 1-inch nominal maximum aggregate size.

D. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

C. Colored Concrete Additive: Made with pure, concentrated mineral pigments processed for mixing into concrete and complying with ASTM C-979.
1. Base dosage rates on proportions of various cementitious materials in mix selected.
2. Color additives containing carbon black are not acceptable.

2.7 FIBER REINFORCEMENT

A. Synthetic Fiber: Polypropylene fibers engineered and designed for secondary reinforcing in concrete slabs, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

2.8 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch .

2.9 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class C not less than 10 mils thick. The water vapor transmission rate should not exceed 0.04 perms per ASTM E 96. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

2.10 CURING MATERIALS

a. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. Contractor to confirm compatibility of selected product with subsequent finishes.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A. Use in all areas subject to vehicular traffic.

H. Curing Compound for Colored Concrete
1. Comply with ASTM C-309.
2. Use only compounds specifically recommended for use with colored concrete.

2.11 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: Standard building paper.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Reglets: Fabricate reglets of not less than 0.0217 inch thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

E. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.12 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.13 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Total pozzolans: no more than 50% by weight of total cementitious material.

C. No chloride-ions are permitted.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures for all horizontal elements (slabs, beams, girders, etc.) in the below grade levels, parking spaces and where else indicated.
5. Mix color additives in accordance with manufacturer's instructions, until additives are uniformly dispersed throughout mixture and disintegrating bags have disintegrated.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Proportion normal-weight concrete mixture as follows:

1. Concrete weight: As indicated on structural drawings.
2. Minimum Compressive Strength: 4,000psi unless otherwise noted on structural drawings, at 28 days for each group of structural elements.
3. Maximum Water-Cementitious Materials Ratio: 0.45.
4. Slump Limit: 3 inches (75 mm), 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
5. Air Content: As follows plus or minus 1.5 percent at point of delivery for each structural element:
   Foundation walls: 5-1/2 percent.
   Slabs-on-Grade: 5-1/2 percent. Do not allow air content of troweled finished floors to exceed 3 percent.
   Suspended Slabs subject to vehicular traffic: 6 percent.
   Suspended Slabs exposed to weather of within 4 feet of finish grade: 6 percent. Do not allow air content of troweled finished floors to exceed 3 percent.
   Suspended slabs (other than referenced above): 4 percent.
   Unless otherwise note above: 4 percent.

2.15 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice", and details indicated on the structural drawings.

2.16 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

2. Construction Manager to inspect batch ticket information prior to placement; deliveries violating mix time limits shall be rejected. Provide copies of tickets to Architect, Structural Engineer and Owner, monthly..

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 75 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

A. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.6 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints in location of control joints, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least [one-fourth] of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks, but no later than 1 hour after completion of finishing operations.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete

that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

G. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

H. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Finishing tolerances for slabs:
1. Finish surfaces to tolerances specified in the following paragraphs, measured according to ASTM E1155 for a randomly trafficked floor surface. Measure preferably within 24 hours, but not more than 72 hours, of concrete placement.
2. Uniformly slope surfaces to drains where required.
3. Correct unacceptable slab tolerances by re-floating, grinding or leveling to achieve specified surface tolerances.
4. Use highway straightedge to re-straighten slabs. Do not use bull floats.
5. Suspended slabs include formed cast in place slabs and slabs n steel deck.
6. Measure before removing shores in formed cast in place slabs.

C. Scratch Finish:

1. Consolidate, strike off, and level concrete, eliminating high spots and low spots.
2. Finish to the following tolerances:
   a. Test area (specified overall F-numbers): Flatness F_F of 15.
   b. Minimum local F-number: Flatness F_F of 13.
3. Roughen surface with stiff brushes or rakes before final set.
4. Locations: Surfaces scheduled to receive thick-set mortar beds or similar cementitious materials, except for thick-set mortar beds on cleavage membranes or on waterproofing membranes

D. Float Finish:

1. After screeding, consolidating and straightening concrete slabs, do not work surface until ready for floating.

2. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats. The application of portland cement to slab during floating or troweling is prohibited.
3. Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
4. Finish to the following tolerances:
   a. Test area (specified overall F-numbers): Flatness F_F of 20 and levelness F_L of 15.
   b. Minimum local F number: Flatness F_F of 15, levelness F_L of 10.
5. Cut down high areas and fill in low areas.
6. After re-straightening, re-float surface to uniform, smooth, granular texture.
7. Locations:
   a. Surfaces scheduled for trowel and broom finishes.
   b. Surfaces scheduled to receive adhered roofing and waterproofing membranes.
   c. Surfaces scheduled to receive thick-set mortar beds on cleavage membranes or on waterproofing membranes.

E. Trowel Finish:

1. After providing float finish, power trowel slab, then hand trowel. Continue troweling and restraighten until ringing sound is produced, and surface is free of trowel marks, pockets, and other defects, and is uniform in texture and appearance. Grind smooth surface defects which would telegraph through applied finishes.
2. Finish to the following tolerances:
   a. Slab on grade:
      1) Test area (specified overall F-numbers): Flatness F_F of 35 and levelness F_L of 25.
      2) Minimum local F-number: Flatness F_F of 24, levelness F_L of 17.
   b. Suspended slabs including slabs on steel deck:
      1) Test area (specified overall F-numbers): Flatness F_F of 30 and levelness F_L of 20.
      2) Minimum local F-number: Flatness F_F of 24, levelness F_L of 15.
   c. For carpeted flooring:
      1) Test area (specified overall F-numbers): Flatness F_F of 25 and levelness F_L of 20.
      2) Minimum local F-number: Flatness F_F of 17, levelness F_L of 15.
3. Locations:
   a. Surfaces scheduled to receive thin-set mortar beds, resilient flooring, epoxy terrazzo, carpet, or wood flooring.
   b. Exposed surfaces.
   c. Surfaces scheduled to receive paint or other thin film finish coatings.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project..

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall

within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 14 days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete, but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's and Structural Engineer’s approval.

3.17 CONSTRUCTION TOLERANCES

A. Variation in alignment, grade and dimensions of structure from those indicated in the Contract Drawings shall be within the tolerances specified under ACI 117 "Specifications for Tolerances for Concrete Construction and Material", the table below, and specific tolerances indicated on the drawings and elsewhere in the specifications whichever is more stringent:

1.	Variation from plumb	1/4 inch in 12 feet 1/2 inch in 40 feet or more
2.	Variation from levelness / flatness	1/4 inch in 10 feet
3.	Variation of dimensions in horizontal direction	1/4 inch in 12 feet 1/2 inch in 40 feet or more
4.	Variation of cross-sectional dimensions for members 12 inches or less.	+3/8 inch, -1/4 inch
5.	Variation of cross-sectional dimensions for members more than 12 inches.	+1/2 inch, -3/8 inch
6.	Variation of cross-sectional dimensions for members more than 36 inches.	+1 inch, -3/4 inch
7.	Variation of footing lateral alignment	0.82x dimension in direction of misplacement but less than 2 inch
8.	Variation of footing and grade beam level alignment	+1/2 inch, -2 inch
9.	Variation of footing cross-sectional dimensions	Horizontal +2 inch, -1/2 inch Thickness –5%

B. All variations are non cumulative and shall be measured from a reference established by the Architect.

PART 4 - QUALITY CONTROL REQUIREMENTS

4.1 GENERAL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Owner's inspection does not relieve the Contractor from Quality Assurance obligations. Repeated and continuous flaws identified by the inspections agency shall result in additional inspections costs which shall be fully paid by and chargeable to the Contractor. Sampling and testing for quality control during placement of concrete shall be done in accordance with IBC 2000 Section 1704 "Special Inspections", shall also include the following.

B. Inspections:

1. Steel reinforcement detailing and placement as indicated on approved shop drawings.
2. Steel reinforcement welding.
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.
6. Construction Manager shall provide pre-placement reports for all concrete verifying that reinforcement, conditions, alignment, etc. are in accordance with Contract Documents

4.2 FIELD QUALITY CONTROL

A. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing is required for all concrete except concrete used for mud slabs with design strength of 2000 psi or less.

2. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.

   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
6. Compression Test Specimens: ASTM C 31/C 31M.

   a. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
   b. All field cured cylinders shall be stored next to the actual concrete elements represented by the cylinders. Use of storage box is not permitted.
   c. All field cured cylinders shall be cured identically to the actual concrete elements represented by the cylinders.

7. Compressive-Strength Tests: ASTM C 39/C 39M;

   a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. Strength of each concrete placement will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
9. Test results shall be reported in writing to Owner, Architect, concrete manufacturer, and Construction Manager within 48 hours of testing. All tests indicating deficiencies shall be immediately reported to same. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in work by at minimum column line grid reference, design compressive strength at 28 days, compressive breaking strength, and type of break for both 7- and 28-day tests.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. All additional testing shall be done at Contractor's expense. Testing and inspecting agency may conduct tests to

determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

12. Additional testing and inspecting will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

B. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48 hours of finishing. Provide report of each test area within 48 hours of measurement to Architect, Cm and Owner.

END OF SECTION

SECTION 033001 – CAST-IN-PLACE CONCRETE – SITE RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Site Retaining walls not connected to the building.

B. Related Sections:
1. Section 312000 "Earth Moving".
2. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements, and for equivalent concrete mixtures that do not contain portland cement replacements.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar

diagrams, bar arrangement, splices and laps, tie spacing, hoop spacing, and supports for concrete reinforcement.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect/Engineer.

F. Samples: For waterstops.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Field quality-control reports.

F. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 318-08 and ACI 350R-06

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.

2. Review inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. High-density overlay, Class 1 or better.
b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
c. Structural 1, B-B or better; mill oiled and edge sealed.
d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice".

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II, gray Supplement with the following:
   a. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag cement. Limit slag to 35% max by weight.

B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. BoMetals, Inc.
   b. Greenstreak.
   c. Paul Murphy Plastics Company.
   d. Vinylex Corp.

2. Profile: Ribbed without center bulb .
3. Dimensions: 9 inches by 3/8 inch; nontapered.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
   b. BASF Construction Chemicals - Building Systems; Confilm.
   c. ChemMasters; SprayFilm.
   d. Conspec by Dayton Superior; Aquafilm.
   e. Dayton Superior Corporation; Sure Film (J-74).
   f. Edoco by Dayton Superior; BurkeFilm.
   g. Euclid Chemical Company (The), an RPM company; Eucobar.

h. Kaufman Products, Inc.; Vapor-Aid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. BASF Construction Chemicals - Building Systems; Kure 200.
c. ChemMasters; Safe-Cure Clear.
d. Conspec by Dayton Superior; W.B. Resin Cure.
e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
f. Edoco by Dayton Superior; Res X Cure WB.
g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
h. Kaufman Products, Inc.; Thinfilm 420.
i. Lambert Corporation; AQUA KURE - CLEAR.
j. L&M Construction Chemicals, Inc.; L&M Cure R.
k. Meadows, W. R., Inc.; 1100-CLEAR.
l. Nox-Crete Products Group; Resin Cure E.
m. Right Pointe; Clear Water Resin.
n. SpecChem, LLC; Spec Rez Clear.
o. Symons by Dayton Superior; Resi-Chem Clear.
p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.8 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 and ACI 350R-06.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Ground Granulated Blast-Furnace Slag: 35 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.9 CONCRETE MIXTURES FOR SITE RETAING WALL ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 5000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.40.
3. Air Content: 6 percent, plus or minus 1.0 percent .
4. Minimum Cement Content Per Cubic Yard: 658 pounds
5. Weight: 145 pounds per cubic foot

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Construct forms tight enough to prevent loss of concrete mortar.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

E. Chamfer exterior corners and edges of permanently exposed concrete.

F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

G. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

H. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

3.3 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Form keyed joints as indicated. Embed keys at least 1-1/2 inch into concrete.
2. Space vertical joints in walls as indicated.

C. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated.

D. Horizontal joints are not permitted in foundations and walls.

3.4 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect/Engineer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

3.6 FINISHING FORMED SURFACES

A. Formed Finish: See landscape plans for types and locations of finishes.

1. Apply to concrete surfaces as indicated on the contract documents.

3.7 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

C. Cure concrete according to ACI 308.1.

3.8 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect/Engineer. Remove and replace concrete that cannot be repaired and patched to Architect/Engineer's approval.

3.9 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:

1. Steel reinforcement placement.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
11. Test results shall be reported in writing to Architect/Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect/Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed y Architect.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033001

SECTION 033010 - SITE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Site Retaining walls not connected to the building.

B. Related Sections:
1. Section 312000 "Earth Moving".
2. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements, and for equivalent concrete mixtures that do not contain portland cement replacements.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar

diagrams, bar arrangement, splices and laps, tie spacing, hoop spacing, and supports for concrete reinforcement.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect/Engineer.

F. Samples: For waterstops.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Field quality-control reports.

F. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 318-08 and ACI 350R-06

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.

2. Review inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. High-density overlay, Class 1 or better.
b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
c. Structural 1, B-B or better; mill oiled and edge sealed.
d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice".

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II, gray Supplement with the following:
   a. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag cement. Limit slag to 35% max by weight.

B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BoMetals, Inc.
    b. Greenstreak.
    c. Paul Murphy Plastics Company.
    d. Vinylex Corp.

2. Profile: Ribbed without center bulb .
3. Dimensions: 9 inches by 3/8 inch; nontapered.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
    b. BASF Construction Chemicals - Building Systems; Confilm.
    c. ChemMasters; SprayFilm.
    d. Conspec by Dayton Superior; Aquafilm.
    e. Dayton Superior Corporation; Sure Film (J-74).
    f. Edoco by Dayton Superior; BurkeFilm.
    g. Euclid Chemical Company (The), an RPM company; Eucobar.

h. Kaufman Products, Inc.; Vapor-Aid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. BASF Construction Chemicals - Building Systems; Kure 200.
c. ChemMasters; Safe-Cure Clear.
d. Conspec by Dayton Superior; W.B. Resin Cure.
e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
f. Edoco by Dayton Superior; Res X Cure WB.
g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
h. Kaufman Products, Inc.; Thinfilm 420.
i. Lambert Corporation; AQUA KURE - CLEAR.
j. L&M Construction Chemicals, Inc.; L&M Cure R.
k. Meadows, W. R., Inc.; 1100-CLEAR.
l. Nox-Crete Products Group; Resin Cure E.
m. Right Pointe; Clear Water Resin.
n. SpecChem, LLC; Spec Rez Clear.
o. Symons by Dayton Superior; Resi-Chem Clear.
p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.8 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 and ACI 350R-06.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Ground Granulated Blast-Furnace Slag: 35 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.9 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 5000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.40.
3. Air Content: 6 percent, plus or minus 1.0 percent .
4. Minimum Cement Content Per Cubic Yard: 658 pounds
5. Weight: 145 pounds per cubic foot

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Construct forms tight enough to prevent loss of concrete mortar.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

E. Chamfer exterior corners and edges of permanently exposed concrete.

F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

G. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

H. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

3.3 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Form keyed joints as indicated. Embed keys at least 1-1/2 inch into concrete.
2. Space vertical joints in walls as indicated.

C. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated.

D. Horizontal joints are not permitted in foundations and walls.

3.4 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect/Engineer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

3.6 FINISHING FORMED SURFACES

A. Formed Finish: See landscape plans for types and locations of finishes.

1. Apply to concrete surfaces as indicated on the contract documents.

3.7 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

C. Cure concrete according to ACI 308.1.

3.8 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect/Engineer. Remove and replace concrete that cannot be repaired and patched to Architect/Engineer's approval.

3.9 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:

1. Steel reinforcement placement.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
11. Test results shall be reported in writing to Architect/Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect/Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed y Architect.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033001

SECTION 033300 - ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place architectural concrete including form facings, reinforcement accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Division 03 Section “Cast In Place Concrete” for structural cast in place concrete.
2. Division 07 Section "Water Repellants" for penetrating water-repellent treatment on cast-in-place architectural concrete.
3. Division 07 Section "Joint Sealants" for elastomeric joint sealants in contraction and other joints in cast-in-place architectural concrete.
4. Division 32 Section "Concrete Paving" for concrete pavement and flatwork finishes.

1.3 DEFINITIONS

A. Cast-in-Place Architectural Concrete: Formed concrete that is exposed to view on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

C. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Formwork Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

E. Samples: For each of the following materials:

1. Form-facing panel.
2. Coarse- and fine-aggregate gradations.

F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 8 by 8 by 2 inches. Include Sample sets showing the full range of variations expected in finishes, colors, and textures.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Form materials and form-release agents.

C. Material Test Reports: For the following, by a qualified testing agency:

1. Aggregates.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "NRMCA Quality Control Manual - Section 3, Certification of Ready Mixed Concrete Production Facilities."

B. Source Limitations for Cast-in-Place Architectural Concrete: Obtain each color, size, type, and variety of concrete material and concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 and Section 6, "Architectural Concrete."
2. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Mockups: Before casting architectural concrete, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, sealers, and contraction joints, as applicable.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for formwork and other form-facing material requirements.

B. Form-Facing Panels for As-Cast Finishes: Steel, glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that will provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

C. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800, "Specification 810.1, Expanded Cellular Glazing Tape"; minimum 1/4 inch thick.

D. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS, that adheres to form joint substrates.

E. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.

F. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

G. Form Ties: Factory-fabricated, glass-fiber-reinforced plastic internally disconnecting ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches from the architectural concrete surface.

2.2 STEEL REINFORCEMENT AND ACCESSORIES

A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI's "Manual of Standard Practice."

1. Where legs of wire bar supports contact forms, use CRSI Class 2, stainless-steel bar supports.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I/II, white.

B. Normal-Weight Aggregates: ASTM C 33, Class 5M coarse aggregate or better, graded. Provide aggregates from single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch.
2. Gradation: Uniformly graded.

C. Water: Potable, complying with ASTM C 94/C 94M except free of wash water from mixer washout operations.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

1. For integrally colored concrete, curing compound shall be approved by color pigment manufacturer.
2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2.5 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.

B. Proportion concrete mixtures as follows:

1. Compressive Strength (28 Days): 5000 psi.
2. Maximum Water-Cementitious Materials Ratio: 0.46.
3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.

2.6 CONCRETE MIXING

A. Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.

1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
2. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for formwork, embedded items, and shoring and reshoring.

B. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.

C. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch.

D. Fabricate forms to result in cast-in-place architectural concrete that complies with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.

1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
2. Do not use rust-stained steel form-facing material.

F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

G. Do not chamfer exterior corners and edges of cast-in-place architectural concrete.

H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 REINFORCEMENT AND INSERTS

A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.

B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Schedule form removal to maintain surface appearance.

B. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

D. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
4. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.5 FINISHES, GENERAL

A. Architectural Concrete Finish: White architectural concrete, smooth surface finish.

3.6 AS-CAST FORMED FINISHES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material to provide smooth finish.

3.7 SURFACE SEALING

A. After cleaning, exterior exposed architectural concrete surfaces shall receive spray applied surface sealer.

1. Apply concrete joint sealants prior to any application of concrete sealer.
2. Apply sealers and sealants in accordance to manufacturer’s specifications.
3. Match accepted field mockup.
4. Adjacent surfaces shall be protected to prevent damage from the surface sealer.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.

B. Begin curing cast-in-place architectural concrete immediately after removing forms from concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:

1. Moisture Curing: Keep exposed surfaces of cast-in-place architectural concrete continuously moist for no fewer than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for no fewer than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.
3. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 FIELD QUALITY CONTROL

A. General: Comply with field quality-control requirements in Division 03 Section "Cast-in-Place Concrete."

3.10 REPAIRS, PROTECTION, AND CLEANING

A. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.

1. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Architect's approval.

B. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.

C. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

D. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

E. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.

1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION 033300

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Face brick.
3. Natural stone trim units.
4. Mortar and grout.
5. Steel reinforcing bars.
6. Masonry joint reinforcement.
7. Ties and anchors.
8. Embedded flashing.
9. Miscellaneous masonry accessories.
10. Cavity-wall insulation.

B. Related Sections:

1. Division 04 Section “Cast Stone Masonry” for cast stone coping and veneer units.
2. Division 05 Section "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
4. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
5. Division 07 Section “Water Repellents” for water repellent treatment of natural stone and cast stone trim units.
6. Division 32 Section "Unit Paving" for exterior unit masonry paving.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For natural stone varieties proposed for use on Project, include test data indicating compliance with physical properties specified or required by referenced ASTM standards.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
4. Reinforcement.

D. Samples for Initial Selection:

1. Face brick, in the form of straps of five or more bricks.
2. Natural stone trim.
3. Colored mortar.
4. Weep holes/vents.

E. Samples for Verification: For each type and color of the following:

1. Face brick, in the form of straps of five or more bricks.
2. Special brick shapes.
3. Natural stone trim: Include at least four samples in each set for each type of stone, exhibiting extremes of the full range of color and other visual characteristics expected in completed Work. Samples will establish the standard by which stone provided will be judged.
4. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
5. Weep holes and vents.
6. Accessories embedded in masonry.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties and material test reports substantiating compliance with requirements.
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence according to ASTM C 67.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Natural Stone Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.

C. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

D. Source Limitations for Natural Stone: Obtain stone, from one quarry with resources to provide materials of consistent quality in appearance and physical properties.

E. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

F. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

G. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate construction quality and aesthetic effects. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.

1. Build sample panel as indicated, including face and backup wythes, joint ties, insulation, base flashing, weep vents, air barrier membrane and accessories.
2. Include window opening as indicated. Demonstrate air barrier terminations and flashing conditions for head, jamb and sill.
3. Include cast stone coping with minimum one head joint illustrating top of wall flashing and stone anchorage.
4. Clean exposed faces of panels with masonry cleaner indicated.
5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; flashing installation; workmanship; aesthetic qualities; and other material and construction qualities specifically approved by Architect in writing.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry and stone to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units for exposed outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Density Classification: Lightweight.
2. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

2.3 MASONRY LINTELS

A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Face Brick: Facing brick complying with ASTM C 216.

1. Basis-of-Design Product:

a. Cloud Ceramics: Light Autumn Blend Velour.

2. Grade: SW.
3. Type: FBX.
4. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
6. Size (Actual Dimensions): 3-5/8 inches wide by 1-5/8 inches high by 11-5/8 inches long.
7. Color and Texture: Match the basis of design product as determined by the Architect.

C. Alternate Products: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Roman brick, Petersen Tegl, D37 Rose.
2. Roman Brick, Consolidated Brick & Building Supplies, Inc.; Desert Island Dark and Desert Island Light, 50/50 blend mingled at factory, Smooth

2.5 NATURAL STONE TRIM UNITS

A. Granite: ASTM C 615.

1. Description: Fine-grained, black stone. Uniform pattern, without veining.

B. Varieties and Sources: Subject to compliance with requirements, provide the following:

1. New England Stone Industries: Jet Mist.

C. Finish: Honed.

D. Provide stone units accurately shaped, with exposed faces dressed true, and with beds and joints at right angles to faces.

2.6 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar colors indicated.

1. Stone trim units to have sealant filled joints.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following]:

a. Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.

b. Lafarge North America; Eaglebond.
c. Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.

D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Davis Colors; True Tone Mortar Colors.
b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
c. Solomon Colors, Inc.; SGS Mortar Colors.

E. Colored Cement Product: Packaged blend made from mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Colored Portland Cement-Lime Mix:

1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
3) Lafarge North America Inc.; Eaglebond Portland & Lime.
4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.

2. Formulate blend as required to produce colors indicated or, if not indicated, as selected from manufacturer's standard colors.
3. Pigments shall not exceed 10 percent of portland cement by weight.
4. Pigments shall not exceed 5 percent of mortar cement by weight.

F. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.

G. Aggregate for Grout: ASTM C 404.

H. Water: Potable.

2.7 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: 0.187-inch diameter.

4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Wire Size for Veneer Ties: 0.187-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet , with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

D. Masonry Joint Reinforcement for Multiwythe Masonry:

1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

2.8 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.
3. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
4. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
5. Stainless-Steel Sheet: ASTM A 666, Type 304.

B. All ties and anchors for natural stone to be stainless steel.

C. Brick Cavity Wall Ties: Wire tie and plate combination system which provides adjustability, minimal free-play, strength, stiffness, positive connection, corrosion-resistance, and is test rated.

1. Basis of Design: Blok-Lok model BL407 by Hohmann & Barnard Company.

D. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of and an amplitude of 0.06 to 0.10 inch made from 0.060-inch- thick, steel sheet, galvanized after fabrication.

E. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

F. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
2. Where wythes do not align are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
3. Wire: Fabricate from 3/16-inch- diameter, hot-dip galvanized steel wire.

G. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch- diameter, hot-dip galvanized steel wire.

2.9 MISCELLANEOUS ANCHORS

A. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

B. Postinstalled Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 unless otherwise indicated.
3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.10 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual"" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.

B. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
3. Elastomeric Sealant: ASTM C 920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

C. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use the following unless otherwise indicated:

1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Heckmann Building Products Inc.; No. 85 Cell Vent.
2) Hohmann & Barnard, Inc.; Quadro-Vent.
3) Wire-Bond; Cell Vent.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Advanced Building Products Inc.; Mortar Break.
b. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
c. Mortar Net USA, Ltd.; Mortar Net.

2. Provide one of the following configurations:

a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.
b. Strips, not less than 1-1/2 inches thick and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.

2.12 CAVITY-WALL INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type X, closed-cell product extruded with an integral skin.

B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

C. Spray Polyurethane Foam: Minimal-expanding, single component polyurethane foam sealant compatible with insulation.

2.13 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without iscoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

2.14 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use mortar cement mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. For mortar parge coats, use Type S or Type N.
4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Pigmented Mortar: Use colored cement product.

1. Pigments shall not exceed 5 percent of mortar cement by weight.
2. Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
3. Mix to match Architect's sample.
4. Application: Use pigmented mortar for all exposed mortar joints.

E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

F. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

1. Application: Use epoxy pointing mortar for exposed mortar joints with the following units:

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set stone trim units on setting blocks and shims. Fill dowel, anchor, and similar holes with mortar.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 SETTING STONE TRIM UNITS WITH SEALANT-FILLED JOINTS

A. Set stone trim units as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Shim and adjust anchors, supports, and accessories to set stone in locations indicated with uniform joints.

B. Keep cavities open where unfilled space is indicated between back of stone units and backup wall; do not fill cavities with mortar or grout.

C. Fill anchor holes with Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

D. Set stone trim units supported on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of stone a distance at least equal to width of joint.

E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.

1. Form open heads joints of width indicated, but not less than 1/8 inch.

F. Prime stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

G. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants."

H. Apply water repellent per Division 07 Section “Water Repellents”.

3.7 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 24 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.

a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.

2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.

a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.
c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement to allow for differential movement regardless of whether bed joints align.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Apply air barrier to face of backup wythe to comply with Division 07 Section "Modified Bituminous Sheet Air Barriers." Air barriers to provide uninterrupted coverage of backup surface, extending continuously behind metal flashings and relieving angles. Flash over flashings and relieving angles after installation with air barrier flashing strips.

D. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Fill all joints and any cracks or open gaps in insulation with spray polyurethane foam compatible with insulation and masonry. Seal all wall ties and other penetrations.

3.8 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.9 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.10 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:
   1. Install preformed control-joint gaskets designed to fit standard sash block.

C. Form expansion joints in brick as follows:
   1. Build in compressible joint fillers where indicated.
   2. Form joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," not less than 3/8 inch.

   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.
   2. Provide lipped brick at shelf angle to maintain the exposed bed joint width.

3.11 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.12 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install sheet metal flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up against air barrier membrane a minimum of 8 inches, and counterflash with air barrier flashing strips.
   3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
   4. Lap end joints of sheet metal flashing not less than 6 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.
2. Space weep holes 24 inches o.c. unless otherwise indicated.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.

3.13 FIELD QUALITY CONTROL

A. Testing and Inspecting: General contractor will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Level 1 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
8. Clean stone trim to comply with stone supplier's written instructions.

3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 047200 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cast stone trim including the following:
   a. Coping.
   b. Veneer.

B. Related Sections:

1. Division 03 Section "Architectural Concrete."
2. Division 04 Section "Unit Masonry" for installing cast stone units with unit masonry.
3. Division 07 Section “Water Repellants” for water repellant treatment of cast stone.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1. Include building elevations showing layout of units and locations of joints and anchors.

D. Samples for Verification:

1. For each color and texture of cast stone required, 10 inches square in size.

E. Full-Size Samples: For each color and texture of cast stone unit required.

1. Make available for Architect's review at Project site.

2. Make Samples from materials to be used for units used on Project.
3. Approved Samples may be installed in the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

1. Include copies of material test reports for completed projects, indicating compliance of cast stone with ASTM C 1364.

B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C 1364, including test for resistance to freezing and thawing.

1. Provide test reports based on testing within previous two years.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, which has sufficient production capacity to manufacture required units, and is a plant certified by the Cast Stone Institute.

B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

C. Source Limitations for Cast Stone: Obtain cast stone units through single source from single manufacturer.

D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.

B. Pack, handle, and ship cast stone units in suitable packs or pallets.

1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.
2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.7 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 CAST STONE UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Arban Precast Stone Ltd.
2. Cast Stone Systems Inc.
3. Hoyle Stone Products
4. Stafford Stone Works Inc.

B. Regional Materials: Cast stone units shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Provide cast stone units complying with ASTM C 1364 using either the vibrant dry tamp or wet-cast method.

1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C 1364.

D. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
3. Provide drips on projecting elements unless otherwise indicated.

E. Fabrication Tolerances:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

F. Cure units as follows:

1. Cure units in enclosed moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
2. Keep units damp and continue curing to comply with one of the following:

    a. No fewer than five days at mean daily temperature of 70 deg F or above.
    b. No fewer than six days at mean daily temperature of 60 deg F or above.
    c. No fewer than seven days at mean daily temperature of 50 deg F or above.
    d. No fewer than eight days at mean daily temperature of 45 deg F or above.

G. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

H. Colors and Textures: As selected by Architect from manufacturer's full range with fine-grained texture and buff color resembling Indiana limestone..

2.2 ACCESSORIES

A. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666.

B. Dowels: 1/2-inch- diameter, round bars, fabricated from Type 304 stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666.

2.3 SOURCE QUALITY CONTROL

A. Engage a qualified independent testing agency to sample and test cast stone units according to ASTM C 1364.

1. Include one test for resistance to freezing and thawing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.

B. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.

C. Fill anchor holes with sealant.

1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

D. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.

1. Form open joint of width indicated, but not less than 3/8 inch.

F. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

G. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants."

H. Apply water repellent per Division 07 Section “Water Repellents”.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

3.4 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone as work progresses.

1. Remove mortar fins and smears before tooling joints.
2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.
3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
5. Clean cast stone by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.

END OF SECTION 047200

STRUCTURAL STEEL- SECTION 051200

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Structural steel.
2. Architecturally exposed structural steel.
3. Grout.

B. Related Sections include the following:

1. Division 5 Section 053100 "Steel Deck".
2. Division 5 Section 055000 "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other metal items not defined as structural steel.
3. Division 9 painting Sections for surface preparation and priming requirements.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.

1.4 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads (service level or ultimate level) indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC's "Manual of Steel Construction" (ASD or LRFD)
2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections and supervise the detailing of the structural steel frame.

B. Construction: Type 2, simple framing.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
5. For structural-steel connections indicated to comply with design loads, include a booklet of all the connections used, with their capacity indicated and a certificate letter both signed and sealed by the qualified professional engineer responsible for their preparation. The letter must certify that all the connections have been designed to withstand the loads indicated on the drawings and meet all the project conditions and design restrictions indicated on the contract documents..

C. Welding certificates.

D. Qualification Data: For Installer, Fabricator, and Professional Engineer

E. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Direct-tension indicators.
4. Tension-control, high-strength bolt-nut-washer assemblies.
5. Shear stud connectors.
6. Shop primers.
7. Nonshrink grout.

F. Source quality-control test reports.

G. LEED Submittals:
1. Credit MR 5.1 and 5.2: There is a goal to achieve credit for products and material regionally manufactured, extracted, harvested or recovered.
   a. Include statement indicating cost and distance from manufacturer to Project for each regionally manufactured material.
   b. Include statement indicating cost and distance from point of extraction, harvest, or recovery to Project for each raw material used in regionally manufactured materials.
2. Credit MR 4.1 and 4.2: Product Data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content.
   a. Include statement indicating costs for each product having recycled content. Contributions to this Credit include recycled content of steel.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CASE.

B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Cbd .

C. Shop-Painting Applicators for AESS steel: Qualified according to AISC's Sophisticated Paint Endorsement P3 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

E. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design "
3. AISC's "Specification for the Design of Steel Hollow Structural Sections."
4. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
5. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

F. Mockups: Build mockups of architecturally exposed structural steel to set quality standards for fabrication and installation.

1. Coordinate finish painting requirements with Division 9 painting Sections.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 COORDINATION

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation. Take field measurements of exact location of embedded anchorage items (anchor bolts etc.) and adjust steel elements detailing as required to ensure proper fitting.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M or ASTM A 572/A 572M, Grade 50 (345).

B. Channels, Angles, M , S-Shapes: ASTM A 36/A 36M or ASTM A 572/A 572M, Grade 50 (345).

C. Plate and Bar: ASTM A 36/A 36M or ASTM A 572/A 572M, Grade 50 (345).

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Weight Class: Standard, Extra strong, Double-extra strong, as indicated on the drawings.
2. Finish: Black, except where indicated to be galvanized.

F. Medium-Strength Steel Castings: ASTM A 27/A 27M, Grade 65-35 (Grade 450-240), carbon steel.

G. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.

1. Finish: Plain, or Mechanically deposited zinc coating, ASTM B 695, Class 50, as indicated or required.
2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8,) compressible-washer type.

a. Finish: Plain, or Mechanically deposited zinc coating, ASTM B 695, Class 50, as indicated or required.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers, plain.

1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M,) Type 10.9, compressible-washer type, plain.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy hex head steel structural bolts with splined ends; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.

1. Finish: Plain, or Mechanically deposited zinc coating, ASTM B 695, Class 50, as indicated or required.

D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

E. Unheaded Anchor Rods: ASTM F1554 grade 36.

1. Configuration: Straight or Hooked as indicated on the drawings.
2. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
3. Plate Washers: ASTM A 36/A 36M carbon steel.
4. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.
5. Finish: Plain, or Mechanically deposited zinc coating, ASTM B 695, Class 50, as indicated or required.

F. Threaded Rods: ASTM A 36/A 36M.

1. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel.
3. Finish: Plain, or Mechanically deposited zinc coating, ASTM B 695, Class 50, as indicated or required.

G. Clevises, Turnbuckles: AISI C-1035, cold-finished carbon steel.

H. Eye Bolts and Nuts: AISI C-1030, cold-finished carbon steel.

I. Sleeve Nuts: AISI C-1018, cold-finished carbon steel.

2.3 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, non-asphaltic, rust-inhibiting primer.

B. Galvanizing Repair Paint: ASTM A 780.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

1. Camber structural-steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6 / A 6M and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.

1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.
2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

D. Bolt Holes: Cut, drill, mechanically**,** or punch standard bolt holes perpendicular to metal surfaces.

E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."

G. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members where indicated on the structural drawings. Obtain written approval of the structural engineer of record and indicate on the shop drawings any holes required but not shown on the structural drawings.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Base-Plate Holes: Cut, drill, mechanically, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. All shop connections shall be welded unless otherwise indicated on the structural drawings

B. Welded Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth in all AESS elements.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances.

    a. Grind butt welds flush.
    b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials.

5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 6 / NACE No. 3, "Commercial Blast Cleaning." for non-AESS elements
   2. SSPC-SP 10 / NACE No. 2, "Near-White Blast Cleaning." for AESS elements.

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Apply a 1-coat, non-asphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.

   1. Galvanize columns, beams, girds, and other framing elements exposed to the weather, in plenums, behind louvers, that will be exposed to humid air.
   2. Galvanize lintels shelf angles attached to structural steel frame and located in exterior walls.
   3. Fabricate galvanized steel items in as large section as can be successfully galvanized.
   4. Cut, drill, and weld galvanized elements as required, prior to galvanizing.
   5. Detail galvanized elements and their connections to allow for dimensional variations due to field conditions without having to modify galvanized assemblies by cutting, drilling, or welding after galvanizing.
   6. Detail galvanized steel items to allow for field assembly with matching galvanizes bolts.
   7. Fill vent holes and grind smooth after galvanizing, on AESS steel only.

2.9 SOURCE QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

   1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, and requirements:

   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.
5. Plates and flanges of steel members:
   Ultrasonically test for delamination in plates and steel member flanges thicker than 1-1/4".
6. Fillet Welds:
   Visually inspect all fillet welds.
   Measure 15% of all fillet welds randomly.
   Perform magnetic particle tests on all fillet welds in moment connections.
   Perform magnetic particle tests on 20% of all fillet welds in connection plates and angles of beams and girders.
7. Full and Partial Penetration Welds:
   Ultrasonically test 100% of all full and partial penetration welds.
   At testing agency's option radiographically test any full pr partial penetration weld that the ultrasonic testing is not conclusive.

2.10 ADJUSTABLE ANCHORS FOR CONNECTING MASONRY TO STRUCTURAL FRAMEWORK.

A. General: Two-piece assemblies as described below allowing vertical or horizontal differential movement between wall and framework parallel to plane of wall, but resisting tension and compression forces perpendicular to it.

B. For anchorage to steel columns provide and install manufacturer's standard mill galvanized crimped wire anchor section welded to steel and as follows:

1. Wire Diameter: 0.25 inch.
2. Provide Hohmann and Barnard #359 and / or #359-C or approved equal.

C. For anchorage to web of steel beams provide and install manufacturer's standard mill galvanized anchor channels with slotted hole welded to steel as shown on the drawings and as follows:

1. Channel Thickness: 11Ga.
2. Provide Hohmann and Barnard #360 and / or #360-C or approved equal.
3. Anchor Spacing: 24 inches on center or closer spacing called on the drawings.

D. For anchorage to underside of steel framework or metal decking, provide manufacturer's standard hot-dip galvanized anchors formed from minimum 12-gauge strips welded or expansion bolted as shown on the drawings and as follows:

1. Anchor Thickness: 12 Ga. minimum
2. Provide Hohmann and Barnard PTA Series Partition Top Anchors #PTA-422 or approved equal.

Anchor Spacing: 24 inches on center or closer spacing called on the drawings

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of base plate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts. Comply with local jurisdictional safety rules.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened or Slip critical where indicated on the drawings.
2. Use Tension Control bolts or tension indicators on all slip critical connections.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth in all AESS elements.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances.

    a. Grind butt welds flush.
    b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1. Using a calibrated torque wrench check all bolts in each shear connection of at least 25% of connections other than Slip Critical type.
2. Visually inspect tension control bolts and tension indicators on all Slip Critical connections.

C. Welded Connections: In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, and requirements:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.
5. Fillet Welds:
   Visually inspect all fillet welds.
   Measure 15% of all fillet welds randomly.
   Perform magnetic particle tests on all fillet welds in moment connections.
   Perform magnetic particle tests on 20% of all fillet welds in connection plates and angles of beams and girders.
6. Full and Partial Penetration Welds:
   Ultrasonically test 100% of all full and partial penetration welds.

At testing agency's option radiographically test any full pr partial penetration weld that the ultrasonic testing is not conclusive.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

END OF SECTION

SECTION 051213 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes architecturally exposed structural-steel framing.

1. Requirements in Division 05 Section "Structural Steel Framing" also apply to AESS framing.

B. Related Sections:

1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Division 05 Section "Structural Steel Framing" for additional requirements applicable to AESS.
3. Division 05 Section "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other metal items not defined as structural steel.
4. Division 05 Section "Metal Stairs."

1.3 DEFINITIONS

A. Architecturally Exposed Structural Steel: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents.

B. Category 1 AESS: AESS that is within 96 inches vertically and 36 inches horizontally of a walking surface and is visible to a person standing on that walking surface or is designated as "Category 1 architecturally exposed structural steel" or "AESS-1" in the Contract Documents.

1.4 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication of AESS components. Shop Drawings for structural steel may be used for AESS provided items of AESS are specifically identified and requirements below are met for AESS.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Indicate grinding, finish, and profile of welds.
4. Indicate exposed surfaces and edges and surface preparation being used.

5. Indicate special tolerances and erection requirements.

B. Samples: Submit samples of AESS to set quality standards for exposed welds for Category 1 AESS.

1. Two steel plates, 3/8 by 8 by 4 inches, with long edges joined by a groove weld and with weld ground smooth.
2. Steel plate, 3/8 by 8 by 8 inches, with one end of a short length of rectangular steel tube, 4 by 6 by 3/8 inches, welded to plate with a continuous fillet weld and with weld ground smooth and blended.
3. Round steel tube or pipe, minimum 8 inches in diameter, with end of another round steel tube or pipe, approximately 4 inches in diameter, welded to its side at a 45-degree angle with a continuous fillet weld and with weld ground smooth and blended.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and fabricator.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

B. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

C. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Use special care in handling to prevent twisting, warping, nicking, and other damage. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 PROJECT CONDITIONS

A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

1.9 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

PART 2 - PRODUCTS

2.1 BOLTS, CONNECTORS, AND ANCHORS

A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Mechanically deposited zinc coating.

2.2 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: ASTM A 780.

D. Shop Primer for Galvanized Steel: Water-based galvanized metal primer complying with MPI#134.

2.3 FABRICATION

A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.

B. In addition to special care used to handle and fabricate AESS, comply with the following:

1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
2. Grind sheared, punched, and flame-cut edges of Category 1 AESS to remove burrs and provide smooth surfaces and edges.
3. Fabricate Category 1 AESS with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
4. Fabricate AESS with exposed surfaces free of seams to maximum extent possible.
5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
7. Fabricate Category 1 AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
8. Seal-weld open ends of hollow structural sections with 3/8-inch closure plates for Category 1 AESS.

C. Curved Members: Fabricate indicated members to curved shape by rolling to final shape in fabrication shop.

1. Distortion of webs, stems, outstanding flanges, and legs of angles shall not be visible from a distance of 20 feet under any lighting conditions.
2. Tolerances for walls of hollow steel sections after rolling shall be approximately 1/2 inch.

D. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch with a tolerance of 1/32 inch for Category 1 AESS.

E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metals.

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.4 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work, and comply with the following:

1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding specified tolerances.
2. Use weld sizes, fabrication sequence, and equipment for AESS that limit distortions to allowable tolerances.
3. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where Category 1 AESS is exposed to weather.
4. Provide continuous welds of uniform size and profile where Category 1 AESS is welded.
5. Grind butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch for Category 1 and Category 2 AESS.
6. Make butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch for Category 1 and Category 2 AESS. Do not grind unless required for clearances or for fitting other components, or unless directed to correct unacceptable work.
7. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for Category 1 and Category 2 AESS.
8. At locations where welding on the far side of an exposed connection of Category 1 and Category 2 AESS occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
9. Make fillet welds for Category 1 and Category2 AESS oversize and grind to uniform profile with smooth face and transition.
10. Make fillet welds for Category 1 and Category 2 AESS of uniform size and profile with exposed face smooth and slightly concave. Do not grind unless directed to correct unacceptable work.

2.5 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

2.6 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to receive sprayed fire-resistive materials.

B. Surface Preparation for Nongalvanized Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Preparing Galvanized Steel for Shop Priming: After galvanizing, thoroughly clean steel of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

D. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to

design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work.
2. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

1. Erect Category 1 AESS to the tolerances specified in AISC 303 for steel that is designated AESS.

B. Do not use thermal cutting during erection.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.
2. Orient bolt heads in same direction for each connection and to maximum extent possible in same direction for similar connections.

B. Weld Connections: Comply with requirements in "Weld Connections" Paragraph in "Shop Connections" Article.

1. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for Category 1 and Category 2 AESS.
2. Remove erection bolts in Category 1 and Category 2 AESS, fill holes, and grind smooth.
3. Fill weld access holes in Category 1 and Category 2 AESS and grind smooth.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect AESS as specified in Division 05 Section "Structural Steel Framing." The testing agency will not be responsible for enforcing requirements relating to aesthetic effect.

B. Architect will observe AESS in place to determine acceptability relating to aesthetic effect.

3.6 REPAIRS AND PROTECTION

A. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Grind steel smooth.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

C. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION 051213

SECTION 053100- STEEL DECK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Roof deck.
   2. Composite floor deck.
   3. Shear Connectors for composite construction.

B. Related Sections include the following:
   1. List below only products and construction that the reader might expect to find in this Section but are specified elsewhere.
   2. Division 3 Section 033000 "Cast-in-Place Concrete" for concrete fill.
   3. Division 5 Section 051200 "Structural Steel" .
   4. Division 5 Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.

C. Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements.

D. Welding Certificates: Copies of certificates for welding procedures and personnel.

E. Product Test Reports: From a qualified testing agency indicating that each of the following complies with requirements, based on comprehensive testing of current products:

   1. Mechanical fasteners.

F. Research/Evaluation Reports: Evidence of steel deck's compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated to conduct the testing indicated, as documented according to ASTM E 548.

C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code - Sheet Steel."

D. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

E. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

F. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1.6 COORDINATION

A. Coordinate layout and installation of trench headers, preset inserts, duct fittings, and other components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steel Deck:
   a. Consolidated Systems, Inc.

b. Epic Metals Corporation.
c. Nucor Corp.; Vulcraft Division.
d. United Steel Deck, Inc.
e. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

2.2 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29, and the following:
1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G90 (Z275) zinc coating.
2. Deck Profile: As indicated on the drawings.
3. Profile Depth: As indicated on the drawings.
4. Design Uncoated-Steel Thickness: As indicated on the drawings.
5. Span Condition: As indicated on the drawings.
6. Side Laps: As indicated on the drawings.

2.3 COMPOSITE FLOOR DECK

A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 29, the minimum section properties indicated, and the following:
1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.
2. Profile Depth: As indicated on the drawings..
3. Design Uncoated-Steel Thickness: As indicated on the drawings.
4. Span Condition: As indicated on the drawings.

2.4 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8 mm) minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0598-inch (1.52-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Steel Sheet Accessories: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

G. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 29 for overhang and slab depth but not less than 0.0747 inch (1.90 mm).

H. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

I. Rolled-in Hanger Tabs: Integral hanger tabs with minimum of 100 lbs allowable load.

J. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch (1.90 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.

K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and level recessed pans of 1-1/2- inch (38-mm) minimum depth. For drains, cut holes in the field.

L. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

M. Shear Connectors: ASTM A 108, Grades 1010 through 1020 headed stud type, cold-finished carbon steel, AWS D1.1, Type B, with arc shields.

N. Galvanizing Repair Paint: ASTM A 780.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions and as permitted on the drawings. Comply with local jurisdictional safety rules.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter, but not less than 1-1/2 inches (38 mm) long, and as follows:

1. Weld Diameter: As indicated on the drawings.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated on the drawings..
3. Weld Washers: Install weld washers at each weld location when welding deck with uncoated steel thickness of 0.03 inch (0.76mm) or less.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 12 inches (300 mm) and as indicated on the drawings.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped 2 inches (51 mm) minimum.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof decking and weld flanges to top of deck. Space welds not more than 6 inches (150 mm) apart with at least 1 weld at each corner.

E. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: As indicated on the drawings..
2. Weld Spacing: Space and locate welds as indicated on drawings.
3. Weld Washers: Install weld washers at each weld location when welding deck with uncoated steel thickness of 0.03 inch (0.76mm) or less..

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals indicated on the drawings:

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches (51 mm) , with end joints as follows:

1. End Joints: Butted.

D. Shear Connectors: Weld shear connectors through deck to supporting frame according to AWS D1.1 and manufacturer's written instructions. Butt end joints of deck panels; do not overlap. Remove and discard arc shields after welding shear connectors.

E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

F. Floor Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field welds will be subject to inspection.

C. Shear connector stud welds will be inspected and tested according to AWS D1.1 for stud welding and as follows:

1. Shear connector stud welds will be 100% visually inspected. Reject and replace any shear connector stud that the visual inspections reveal less than a full 360-degree flash or welding repairs
2. Testing of shear connector studs shall be done by bending the stud to an angle of 45 degrees from the vertical. Test shall be considered passed if no weld cracking or failure is evident after the bending.
3. Weld two studs at start of each daily production period and for each welding apparatus used, to determine proper weld setup. Perform test. If test fails, correct or adjust setup and repeat test. Two consecutive studs must be successfully welded and satisfactorily tested before any production studs are welded.
4. Throughout the day provide and test 12 additional studs per each welding apparatus used.
5. For every stud that fails three additional studs must be tested.
6. Provide one additional stud for every bent one so that the number of studs per beam is not reduced.

D. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

E. Remove and replace work that does not comply with specified requirements.

F. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior non-load-bearing wall framing.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections.
2. Division 07 Section “Composite Wall Panels” for secondary metal framing associated with composite metal wall panel rain screen assembly.
3. Division 09 Section "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
4. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height.

3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

a. Upward and downward movement of 1 inch.

B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."

1. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

1.4 SUBMITTALS

A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.

a. Include statement indicating costs for each product having recycled content.

C. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Qualification Data: For professional engineer.

E. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

1.5 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.

D. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

E. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

F. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:

1. Dale/Incor.
2. Dietrich Metal Framing; a Worthington Industries Company.
3. MarinoWare; a division of Ware Industries.

2.2 MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: G90 or equivalent.

C. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50, Class 1 or 2.

2. Coating: G90.

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.
2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips: Manufacturer's standard bypass clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Dietrich Metal Framing; a Worthington Industries Company.
b. MarinoWare, a division of Ware Industries.
c. SCAFCO Corporation

2.4 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Gusset plates.
7. Stud kickers, knee braces, and girts.
8. Backer plates.

2.5 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 55, threaded carbon-steel hex-headed bolts or headless, hooked bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.

B. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.7 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

    a. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

B. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

C. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

D. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

E. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

F. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

G. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:

1. Stud Spacing: 16 inches.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Connect vertical deflection clips to bypassing or infill studs and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection. Provide one of the following:

1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for operable partitions.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Elevator machine beams, hoist beams,.
5. Steel shapes for supporting elevator door sills.
6. Shelf angles.
7. Metal ladders.
8. Metal ships' ladders.

B. Products furnished, but not installed, under this Section:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Division 05 Section "Structural Steel Framing."
4. Division 05 Section "Metal Stairs."
5. Division 05 Section "Pipe and Tube Railings."
6. Division 05 Section "Decorative Metal."
7. Division 05 Section "Decorative Metal Railings."
8. Division 12 Section "Site Furnishings" for bicycle racks.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Paint products.
3. Grout.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves,

concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

C. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

D. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3 unless otherwise indicated.
2. For elevator pit ladders, comply with ASME A17.1.

B. Elevator Pit Steel Ladders:

1. Space siderails of elevator pit ladders 12 inches apart.
2. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
3. Rungs: 3/4-inch- diameter steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.

C. Exterior Steel Ladders:

1. Galvanize exterior ladders, including brackets and fasteners.
2. Space siderails 18 inches apart unless otherwise indicated.
3. Siderails: Continuous, 1-1/2-inch diameter schedule 40 galvanized steel pipe.
4. Rungs: 3/4-inch- diameter steel bars.
5. Fit rungs in centerline of siderails; plug-weld and grind smooth.

6. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
7. Support each ladder at top and bottom and not more than 48 inches o.c. with welded steel brackets.

2.9 METAL SHIPS' LADDERS

A. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Fabricate ships' ladders, including railings from steel.
2. Fabricate treads from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 1/2 inch in least dimension.
3. Fabricate treads from abrasive-surface floor plate.
4. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."

B. Primesteel ships' ladders, including treads, railings, brackets, and fasteners, with zinc-rich primer.

2.10 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

2.11 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.12 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 055100 - METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with concrete-filled treads.
2. Ornamental steel-framed stairs.
3. Steel flat bar railings attached to metal stairs.
4. Steel tube handrails attached to walls adjacent to metal stairs.

B. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
2. Division 05 Section “Decorative Metal Railings” for glass and steel railings for ornamental steel-framed stairs.
3. Division 09 Section "Non-Structural Metal Framing" for metal backing for anchoring railings.
4. Division 09 Section "Resinous Matrix Terrazzo Flooring" for terrazzo treads and landings for ornamental steel-framed stairs.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft..
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/240 or 1/4 inch, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
b. Infill load and other loads need not be assumed to act concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Prefilled metal-pan stair treads.
2. Paint products.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Samples for Verification: For the following products, in manufacturer's standard sizes:

1. Metal floor plate treads.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Preassembled Stairs: Commercial class.
2. Ornamental Stairs: Architectural class.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Wire Rod for Grating Crossbars: ASTM A 510.

D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

E. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, structural steel, Grade 25, unless another grade is required by design loads; exposed.

F. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30, unless another grade is required by design loads.

2.3 NONFERROUS METALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

B. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

C. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).

D. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

E. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.4 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

D. Machine Screws: ASME B18.6.3.

E. Lag Screws: ASME B18.2.1.

F. Plain Washers: Round, ASME B18.22.1.

G. Lock Washers: Helical, spring type, ASME B18.21.1.

H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

D. Welded Wire Fabric: ASTM A 185/A 185M, 6 by 6 inches, W1.4 by W1.4, unless otherwise indicated.

2.6 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.7 STEEL-FRAMED STAIRS

A. Stair Framing:

1. Fabricate stringers of steel channels.

a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of steel channel or tube headers and miscellaneous framing members as needed to comply with performance requirements.
3. Weld stringers to headers; weld framing members to stringers and headers.
4. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

B. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067 inch.

1. Steel Sheet: Uncoated cold-rolled steel sheet.
2. Shape metal pans to include nosing integral with riser.
3. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

2.8 ORNAMENTAL STEEL-FRAMED STAIRS (DESIGNATED STAIR A)

A. Stair Framing:

1. Fabricate stringers of steel plate as indicated.
2. Construct platforms of steel plate headers and miscellaneous framing members as needed to comply with performance requirements.
3. All connections welded and ground smooth.

B. Steel Plate Treads: Form subtreads and subplatforms to configurations shown from steel plate of thickness needed to comply with performance requirements but not less than 1/2 inch.

1. Directly weld steel plate treads to stringers; locate welds on top of subtreads where they will be concealed. Do not weld risers to stringers.
2. Shape metal pans as indicated to carry precast terrazzo treads in setting bed.
3. Provide subplatforms of configuration indicated. Weld subplatforms to stringers. Weld subplatforms and stringers to platform framing.

    a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

C. Perforated stainless steel risers: Form risers to configurations shown from steel sheet of thickness indicated.

1. Perforated steel sheet to extend width of tread with 3/8” diameter holes in staggered pattern.
2. risers to have 1” solid margin at each end of tread with finished end pattern.

2.9 STAIR RAILINGS

A. Steel Flat Bar Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Posts: Paired 1/2-inch by 1-1/2-inch steel flat bars with 1/2-inch spacers.
2. Bottom and Intermediate Rails: 1/2-inch by 1-1/2-inch steel flat.
3. Top Rail: 1-inch by 1-1/2-inch steel flat.
4. Picket Infill: 1/2-inch- square pickets spaced less than 4 inches clear.
5. Handrails: 1-1/4-inch nominal diameter schedule 40 steel pipe.
6. Handrail Mounting Brackets: Formed from ¼-inch by 1-inch bent flat bar.

a. For handrails mounted to walls, weld bracket to 3-1/4-inch diameter by ¼-inch thick round escutcheon plate – ease plate edge with 1/8-inch chamfer.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

C. Form changes in direction of railings as follows:

1. By flush bends.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.

1. Connect posts to stair framing by direct welding unless otherwise indicated.
2. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.10 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Steel Framed Stairs: Shop prime and field paint.

1. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
2. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise

indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

D. Ornamental Steel Framed Stairs: Polyester powder coat.

1. Prepare uncoated ferrous-metal surfaces as recommended by finish coat manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

G. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-Place Concrete."

3.2 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

END OF SECTION 055100

SECTION 055213 - EXTERIOR PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel pipe and tube railings.
2. Stain-less steel railings.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Steel: 72 percent of minimum yield strength.
2. Stainless steel: 60 percent of minimum yield strength.

C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails:

a. Uniform load of 50 lbf/ ft. applied in any direction (or current code requirement).
b. Concentrated load of 200 lbf applied in any direction (or current code requirement).
c. Uniform and concentrated loads need not be assumed to act concurrently.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For products involving selection of color, texture, or design including finishes on stainless steel.

D. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.

a. Show method of connecting and finishing members at intersections.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Qualification Data: For qualified professional engineer and testing agency.

G. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

H. Welding certificates.

I. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

J. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of stairs, walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.7 COORDINATION AND SCHEDULING

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in, or otherwise connected to, concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: railings to be fabricated by firm with minimum 5 years experience at manufacturing similar products.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 STEEL AND IRON

A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. A. Tubing: ASTM A 500 (cold formed) or ASTM A 513.

C. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide finishes as indicated.

D. Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.4 STAINLESS STEEL

A. Tubing: ASTM A 554

B. Pipe: ASTM A 312

C. Castings: ASTM A 743

2.5 FASTENERS

A. General: Provide the following:
1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM 1941, Class Fe/Zn 5 for zinc coating
2. Hot-Dip Galvanized Railings: Type 316 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
3. Stainless-Steel Railings: Type 304 stainless steel fasteners.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:
1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
2. Provide tamper-resistant square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
1. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
1. For stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Shop Primers: Provide primers that comply with Painting specs for exterior use.

E. Universal Shop Primer: Fast-curing, lead and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

F. Epoxy Zinc-Rich Primer: Comply with MPI#20 and compatible with topcoat.

G. Intermediate Coats and Topcoats: Provide high performing products specifically made for exterior applications.

H. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.

I. Polyurethane Topcoat: Complying with MPI #&@ and compatible with undercoat.

J. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for exterior applications.

K. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

   1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.7 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Form changes in direction as follows:

1. By radius bends of radius indicated.

J. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

K. Close exposed ends of railing members with prefabricated end fittings.

L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.9 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
4. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

D. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3 "Commercial Blast Cleaning."

F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specifications No. 1: Shop, Field, and Maintenance Painting of Steel", for shop painting.

G. Shop Painted Finish: Baked on powder coat.

H. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Filed, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: Steel railing color to be RAL 9007 Grey Aluminum.

2.10 STAINLESS STEEL FINISHES

A. Remove tool and die marks and stretch lines, or blend into finish.

B. Grind and polish surfaces to product uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. 180-Grit polish Finish: Oil-ground, uniform, directionally textured finish. (provide samples of 180-Grit Finish, 320-Grit Finish, Polished and Buffed Finish, Direction Satin No.4 and Dull Satin No. 6 Finishes).

D. When polish is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with installer present, for compliance with requirements for correct and level finish grade, mounting surfaces, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Non-welded Connection: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ADJUSTING AND CLEANING

A. Clean stainless steel railings by washing thoroughly with clean water and soap and rising with clean water.

B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same materials as used for shop painting to comply with SSPC-PA 1 for touching up shop=painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil. Dry film thickness.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.5 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

SECTION 057300 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Post-supported railings with glass infill.

B. Related Sections:

1. Division 05 Section "Metal Stairs" for railings included with metal stairs.
2. Division 06 Section “Miscellaneous Rough Carpentry" for wood blocking for anchoring railings.
3. Division 09 Section "Non-Structural Metal Framing" for metal backing for anchoring railings.

1.3 DEFINITIONS

A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas, pedestrian guidance and support, visual separation, or wall protection.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
b. Infill load and other loads need not be assumed to act concurrently.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made by Owner. Retesting of products that fail to meet specified requirements shall be done at Contractor's expense.

1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
2. Test railings according to ASTM E 894 and ASTM E 935.

1.6 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of railings assembled from standard components.
2. Grout, anchoring cement, and paint products.

B. LEED Submittals:

1. Laboratory Test Reports for Credit IEQ 4: For paints and coatings on interior decorative metal items, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. For illuminated railings, include wiring diagrams and roughing-in details.

D. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.

E. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Each type of glass required.
3. Fittings and brackets.
4. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.

1.7 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

C. Preconstruction test reports.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including structural analysis, preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of railings and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

E. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups as shown on Drawings.
2. Build mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 24 inches in length.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not suit structural performance requirements.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

1. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
2. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.

2.2 GLASS AND GLAZING MATERIALS

A. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.

1. Glass Color: Clear.
2. Thickness for Glass Infill Panels: As required by structural loads, but not less than 12.0 mm.

B. Glazing Clamps for Glass Infill Panels: Satin finish no. 304 stainless steel, round shape.

2.3 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

H. Form changes in direction as follows:

1. As detailed.

I. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

J. Close exposed ends of hollow railing members with prefabricated end fittings.

K. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.

L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.5 GLAZING PANEL FABRICATION

A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

1. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces
2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.

B. Infill Panels: Provide tempered glass panels.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

3.4 ANCHORING POSTS

A. Attach railing posts with through penetration welds.

3.5 ATTACHING RAILINGS

A. Weld attach handrails and handrail brackets to posts.

3.6 INSTALLING GLASS PANELS

A. Post-Supported Glass Railings: Weld attach glazing clamps to railing posts. Do not cut, drill, or alter glass panels in field. Protect edges from damage.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Railings will be tested according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and will comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 CLEANING

A. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

3.9 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 057300

SECTION 057500 - DECORATIVE FORMED METAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Beam wraps.
2. Column covers.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for non-decorative metal fabrications.
2. Section 057300 "Decorative Metal Railings."
3. Section 076100 "Sheet Metal Roofing" for items made of formed metal for roofing.
4. Section 076200 "Sheet Metal Flashing and Trim" for items made of formed metal for flashings and trim.
5. Section 077100 "Roof Specialties" for items made of formed metal for parapets and copings.
6. Section 081113 "Hollow Metal Doors and Frames" for flush hollow-metal doors and frames receiving decorative metal cladding.
7. Section 089000 "Louvers and Vents" for louvers made of formed metal.
8. Section 142400 "Hydraulic Elevators" for elevator cab and entrance components made from sheet metal.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include finishing materials.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

C. Shop Drawings: Show fabrication and installation details for decorative formed metal.

1. Include plans, elevations, component details, and attachments to other work.
2. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Samples for Initial Selection: For products involving selection of color, texture, or design.

E. Samples for Verification: For each type of exposed finish required, prepared on 6-inch- square Samples of metal of same thickness and material indicated for the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Installer Qualifications: Fabricator of products.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for the following types of decorative formed metal:

a. Atrium column surround.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

B. Store products on elevated platforms in a dry location.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes.

PART 2 - PRODUCTS

2.1 SHEET METAL

A. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, exposed.

2.2 MISCELLANEOUS MATERIALS

A. Sealants, Interior: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834; of type and grade required to seal joints in decorative formed metal; and as recommended in writing by decorative formed metal manufacturer.

1. Use sealant that has a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless otherwise indicated.
2. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

C. Backing Materials: Provided or recommended by decorative formed metal manufacturer.

2.3 FABRICATION, GENERAL

A. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch- wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch and support with concealed stiffeners.

D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.

1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

E. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.

F. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.

G. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

1. Use welding and brazing procedures that will blend with and not cause discoloration of metal being joined.

2.4 BEAM WRAPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Industrial Louvers Inc.
2. Metal Sales & Service, Inc.; Metalwerks Division.
3. MM Systems Corporation.

B. Form beam wraps from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

1. Steel Sheet: 0.060 inch.

a. Finish: Powder coat.

2.5 COLUMN COVERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Industrial Louvers Inc.
2. Metal Sales & Service, Inc.; Metalwerks Division.
3. MM Systems Corporation.

B. Sheet Metal Perforated Column Covers: Form custom fabricated column covers to shapes indicated from metal of type and minimum thickness indicated below.

1. Steel Sheet: 0.135 inch thickness (10 gage).

   a. Finish: Powder coat.
   b. Color: RAL 9006 “White Aluminum”.

2. Form sharp corner returns at vertical edges to provide hairline joints.
3. Fabricate column covers without horizontal joints.
4. System shall be designed so that covers can be removed or installed without damage. Column closures shall be anchored in a manner to have clip angles and fasteners concealed. Fasteners to be non-corrosive types.
5. Installation Tolerances: Panels to be installed within a tolerance of 1/4" in 20' on level/plumb/slope and location/line as shown on shop drawings and within 1/8" offset of adjoining faces and of alignment of matching profiles.
6. Backing: Provide permanent reinforcement recommended by manufacturer to prevent deformation, denting or damage. Do not blank-off behind perforation pattern.
7. Structural Steel Column Finish: Paint structural steel as per Section 09900 before installation of stainless steel column cover.

C. Ceiling Rings: Fabricate ceiling rings to for tight closure of steel column penetrations at sloped ceiling.

2.6 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.

C. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

   1. Color and Gloss: As indicated or if not indicated, then as selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.

E. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.

F. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

3.3 ADJUSTING AND CLEANING

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

C. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 057500

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wood blocking and nailers.
2. Plywood backing panels.

B. Related Requirements:

1. Division 06 Section "Sheathing."
2. Division 06 finish carpentry Sections for nonstructural carpentry items exposed to view and not specified in another Section.

1.3 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NHLA: National Hardwood Lumber Association.
2. SPIB: The Southern Pine Inspection Bureau.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. LEED Submittals:

1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Certified Wood: Lumber and plywood shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
4. Provide dressed lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
   1. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

   1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.

D. Application: Treat items indicated on Drawings, and the following:

   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

   1. Use treatment that does not promote corrosion of metal fasteners.
   2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
   3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

   1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Cants.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exterior, AC, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Power-Driven Fasteners: NES NER-272.

C. Screws for Fastening to Metal Framing: ASTM C 1002 or ASTM C 954, length as recommended by screw manufacturer for material being fastened.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

C. Do not splice structural members between supports unless otherwise indicated.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

E. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

G. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

3.2 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Composite nail base insulated roof sheathing.
3. Sheathing joint and penetration treatment.

B. Related Requirements:

1. Division 06 Section “Miscellaneous Rough Carpentry" for plywood backing panels.
2. Division 07 Section "Modified Bituminous Sheet Air Barriers" for water-resistive barrier applied over gypsum board substrate.
3. Division 07 “Thermal Insulation” for foam-plastic board insulation installed over sheathing.
4. Division 07 “Composite Wall Panels” for composite wall panels installed over wall sheathing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

B. LEED Submittals:

1. Credit MR 4: Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating cost for each product having recycled content.
2. Certificates for Credit MR 7: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory.".

2.2 WALL SHEATHING

A. Gypsum Sheathing – Provide one of the following:

1. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177.

a. Products: Subject to compliance with requirements, provide one of the following:

1) CertainTeed Corporation; GlasRoc.
2) G-P Gypsum Corporation; Dens-Glass Gold.
3) National Gypsum Company; Gold Bond e(2)XP.
4) Temple-Inland Inc.; GreenGlass
5) United States Gypsum Co.; Securock.

b. Type and Thickness: Type X, 5/8 inch thick.

2. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C 1278, gypsum sheathing.

a. Product: Subject to compliance with requirements, provide "Fiberock Sheathing with Aqua-Tough" by United States Gypsum Co.
b. Type and Thickness: Type X, 5/8 inch thick.

2.3 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: Rigid, cellular, polyisocyanurate thermal insulation with oriented strand board laminated to one face complying with ASTM C 1289, Type V.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cornell Corporation.
b. Dow Chemical Company (The).
c. Johns Manville; Berkshire Hathaway Inc.

d. Rmax, Inc.

2. Polyisocyanurate-Foam Thickness: 3 inches.
3. Oriented-Strand-Board Nominal Thickness: 7/16 inch.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

B. Power-Driven Fasteners: NES NER-272.

C. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

2.5 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."

D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to cold-formed metal framing with screws.
2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.
2. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

E. Seal sheathing joints according to sheathing manufacturer's written instructions.

1. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to

exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION 061600

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior wood frames and jambs.
2. Plastic-laminate cabinets.
3. Plastic-laminate countertops.
4. Shop finishing of interior woodwork.

B. Related Sections include the following:

1. Division 06 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
2. Division 06 Section “Flush Wood Paneling” for wood-veneer wall surfacing.
3. Division 08 Section “Flush Wood Doors” for wood doors for installation in wood frames.
4. Division 12 Section “Solid Surface Countertops and Wall Panels” for solid-surface-material countertops and quartz-surface wall panels.

1.3 DEFINITIONS

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.

B. Product Data: For panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, cabinet hardware and accessories, and finishing materials and processes.

C. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Certificates for Credit MR 7: Chain-of-custody certificates indicating that interior architectural woodwork complies with forest certification requirements. Include

documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.

3. Product Data for Credit IEQ 4.1: For installation adhesives, documentation including printed statement of VOC content.
4. Product Data for Credit IEQ 4.4: For composite wood products and adhesives, documentation indicating that product contains no urea formaldehyde.
5. Laboratory Test Reports for Credit IEQ 4: For adhesives, composite wood products, and finishing materials, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes installed in architectural woodwork.
4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.

E. Samples for Initial Selection:

1. Shop-applied opaque finishes.
2. Plastic laminates.
3. PVC edge material.
4. Thermoset decorative panels.

F. Samples for Verification:

1. Lumber with or for transparent finish, not less than 50 sq. in., for each species and cut, finished on 1 side and 1 edge.
2. Veneer leaves representative of and selected from flitches to be used for transparent-finished woodwork.
3. Lumber and panel products with shop-applied opaque finish, 50 sq. in. for lumber and 8 by 10 inches for panels, for each finish system and color, with exposed surface finished.
4. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish.
5. Thermoset decorative-panels, 8 by 10 inches, for each type, color, pattern, and surface finish.
6. Exposed cabinet hardware and accessories, one unit for each type.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of product, signed by product manufacturer.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Certified participant in AWI's Quality Certification Program.

B. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers and wood doors with face veneers that are sequence matched with woodwork.

C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide AWI Quality Certification Program labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.9 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.1 WOODWORK FABRICATORS

A. Available Fabricators: Subject to compliance with requirements, fabricators offering interior architectural woodwork that may be incorporated into the Work include, but are not limited to, the following:

2.2 MATERIALS

A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Certified Wood: Interior architectural woodwork shall be produced from wood obtained from forests certified by an FSC accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

C. Wood Species and Cut for Transparent Finish: Red oak, plain sawn or sliced.

D. Wood Products: Comply with the following:

1. Low-Emitting Materials: Composite wood products shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
2. Hardboard: AHA A135.4.
3. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
4. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.
5. Softwood Plywood: DOC PS 1.
6. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.

E. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

1. Provide PVC or polyester edge banding complying with LMA EDG-1 on components with exposed or semiexposed edges.

F. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:

a. Formica Corporation.
b. Nevamar Company, LLC; Decorative Products Div.
c. Wilsonart International; Div. of Premark International, Inc.

2.3 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening.

C. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.

D. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

E. Drawer Slides: BHMA A156.9, B05091.

1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
2. Box Drawer Slides: Grade 1HD-100; for drawers not more than 6 inches high and 24 inches wide.
3. File Drawer Slides: Grade 1HD-200; for drawers more than 6 inches high or 24 inches wide.

F. Door Locks (all doors): BHMA A156.11, E07121.

G. Drawer Locks (all drawers): BHMA A156.11, E07041.

H. Grommets for Cable Passage through Countertops: 2-inch OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Product: Subject to compliance with requirements, provide “SG series" by Doug Mockett & Company, Inc.

I. Label holders: Steel, nickel plated, nominal 2-inch wide by 1-inch high for screw attachment to face of all cabinet doors & drawer fronts.

1. Product: Subject to compliance with requirements, provide Item No. HAF-58709 by Hafele America Co.

J. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Stainless Steel: BHMA 630.

K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

C. Adhesives, General: Adhesives shall not contain urea formaldehyde.

D. Low-Emitting Materials: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-cale Environmental Chambers."

E. VOC Limits for Installation Adhesives: Installation adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.
2. Multipurpose Construction Adhesives: 70 g/L.
3. Contact Adhesive: 250 g/L.

2.5 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium-grade interior woodwork complying with referenced quality standard.

B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch.

D. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

E. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of openings in countertops with a coat of varnish.

2.6 INTERIOR FRAMES AND JAMBS FOR TRANSPARENT FINISH

A. Wood Species and Cut: White oak, plain sawn.

B. For frames or jambs wider than available lumber, use veneered construction. Do not glue for width.

2.7 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural plastic-laminate cabinets indicated for construction, finishes, installation, and other requirements.

B. Grade: Premium.

C. Regional Materials: Plastic-laminate cabinets shall be manufactured within 500 miles of Project site.

D. Certified Wood: Plastic-laminate cabinets shall be made from wood products certified as "FSC Pure" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

E. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.

F. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Formica Corporation.
b. Panolam Industries International, Inc.
c. Wilsonart International; Div. of Premark International, Inc..

G. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS.
2. Postformed Surfaces: Grade HGP.
3. Vertical Surfaces: Grade HGS.
4. Edges: Grade HGS.

H. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.

a. Edges of Plastic-Laminate Shelves: PVC T-mold matching laminate in color, pattern, and finish.
b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
3. Drawer Bottoms: Thermoset decorative panels.

I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued dovetail joints.

K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As selected by Architect from laminate manufacturer's full range in the following categories:

a. Solid colors, matte finish.
b. Wood grains, matte finish.
c. Patterns, matte finish.

L. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.8 PLASTIC-LAMINATE COUNTERTOPS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades indicated for construction, installation, and other requirements.

B. Grade: Premium.

C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.

D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As selected by Architect from manufacturer's full range in the following categories:

a. Solid colors, matte finish.
b. Wood grains, matte finish.
c. Patterns, matte finish.

2. Grain Direction: Parallel to cabinet fronts.

E. Edge Treatment: Same as laminate cladding on horizontal surfaces.

F. Core Material: Particleboard or medium-density fiberboard.

G. Core Thickness: 3/4 inch.

1. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.

H. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.

2.9 SHOP FINISHING

A. Grade: Provide finishes of same grades as items to be finished.

B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require

backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.

D. Transparent Finish:

1. AWI Finish System: Catalyzed lacquer with a "water white" top coat, matte finish (low sheen) to match Architect's sample.
2. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.

B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

F. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips.

G. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
3. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

H. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064023

SECTION 064216 - FLUSH WOOD PANELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Flush wood paneling (wood-veneer wall surfacing).
2. Wood furring, blocking, shims, and hanging strips for installing flush wood paneling unless concealed within other construction before paneling installation.
3. Shop finishing of flush wood paneling.

B. Related Requirements:

1. Division 06 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing paneling and that are concealed within other construction before paneling installation.
2. Division 06 Section “Interior Architectural Woodwork” for wood trim and frames
3. Division 08 Section “Flush Wood Doors” for wood door veneers from the same flitches for both flush wood doors and wood paneling.
4. Section 102238 “Operable Panel Partitions” for coordination of wood veneer wall panels to be installed on movable partition.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including panel products adhesives and finishing materials and processes.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

3. Certificates for Credit MR 7: Chain-of-custody certificates indicating that paneling complies with forest certification and chain-of-custody requirements. Include statement indicating cost for each certified wood product.
4. Product Data for Credit IEQ 4.1: For installation adhesives, documentation including printed statement of VOC content.
5. Product Data for Credit IEQ 4.4: For composite wood products and fabrication adhesives, documentation indicating that products contain no urea formaldehyde.

C. Shop Drawings: Show location of paneling, large-scale details, attachment devices, and other components. Include dimensioned plans and elevations.

1. Show details full size.
2. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
3. For paneling produced from premanufactured sets, show finished panel sizes, set numbers, sequence numbers within sets, and method of cutting panels to produce indicated sizes.
4. For paneling veneered in fabrication shop, show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
5. Apply WI Certified Compliance Program label to first page of Shop Drawings.

D. Samples for Initial Selection:

1. Shop-applied transparent finishes.

E. Samples for Verification:

1. Lumber for transparent finish, not less than 5 inches wide by 12 inches long, for each species and cut, finished on one side and one edge.
2. Veneer leaves representative of and selected from flitches to be used for transparent-finished paneling.
3. Veneer-faced panel products for transparent finish, 12 by 24 inches, for each species and cut. Include at least one face-veneer seam and finish as specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer Fabricator.

B. Product Certificates: For each type of product.

C. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

D. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.

B. Installer Qualifications: Fabricator of products.

C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of typical paneling as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver paneling until painting and similar operations that could damage paneling have been completed in installation areas. If paneling must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install paneling until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where paneling is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support paneling by field measurements before being enclosed and indicate measurements on Shop Drawings.

C. Established Dimensions: Where paneling is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.9 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that paneling can be installed as indicated.

PART 2 - PRODUCTS

2.1 PANELING FABRICATORS

A. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of paneling and wood trim, wood frames, and wood doors faced with veneers from same flitches as paneling.

B. Fabricators: Subject to compliance with requirements, available fabricators offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cavetown Planing Mill Co.; PO Box 5, Cavetown, MD 21720-0051
2. Country Designs Inc.; 2498 Iron Springs Rd, 17320 Fairfield, PA

2.2 PANELING, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of flush wood paneling (wood-veneer wall surfacing) indicated for construction, finishes, installation, and other requirements.

1. Provide labels and certificates from AWI certification program indicating that paneling, including installation, complies with requirements of grades specified.
2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

B. Regional Materials: Paneling shall be manufactured within 500 miles of Project site.

1. Composite wood materials used for paneling shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered within 500 miles of Project site.
2. Veneers used for paneling shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered within 500 miles of Project site.
3. Lumber used for paneling shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered within 500 miles of Project site.

2.3 FLUSH WOOD PANELING (WOOD-VENEER WALL SURFACING)

A. Grade: Premium.

B. Certified Wood: Wood and composite wood components of flush wood paneling shall be certified as "FSC Pure" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

C. Wood Species and Cut: Select, quarter sliced, Clear White Oak with medium flake.

D. Matching of Adjacent Veneer Leaves: Slip match.

E. Matching within Panel Face: Center-balance match.

F. Matching of Adjacent Veneer Leaves and within Panel Face: Slip, center, book match.

G. Panel-Matching Method: Made-to-order, sequence-matched panels within each separate area.

1. Refer to Section 011000 "Summary" for requirements concerning flitches reserved by Architect.

H. Panel Core Construction: Fire-retardant medium-density fiberboard.

1. Thickness: ¾-inch for wall mounted panels, ½-inch thick for panels mounted on the operable panel partition.

I. Exposed Panel Edges: Inset solid-wood or wood-veneer matching faces.

J. Assemble panels by gluing and concealed fastening.

2.4 MATERIALS

A. Materials, General: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.

B. Wood Moisture Content: 5 to 10 percent.

C. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each quality grade specified unless otherwise indicated.

1. Recycled Content of Medium-Density Fiberboard and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 80 percent.
2. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.

D. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.5 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced woodworking standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals

mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Panel Source International, Inc., McKillican America, Inc.; Pyroblock Platinum.
   b. SierraPine; Medite FR.

2.6 INSTALLATION MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls.

C. VOC Limits for Installation Adhesives: Use products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.
2. Multipurpose Construction Adhesives: 70 g/L.
3. Contact Adhesive: 80 g/L.
4. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.

2.7 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Complete fabrication, including assembly and finishing, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

C. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

2.8 SHOP FINISHING

A. General: Finish paneling at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing paneling, as applicable to each unit of work.

1. Backpriming: Apply two coats of sealer or primer, compatible with finish coats, to concealed surfaces of paneling. Concealed surfaces of plastic-laminate-clad paneling do not require backpriming when surfaced with plastic laminate.

C. Transparent Finish:

1. Grade: Premium.
2. Finish: System – AWI System TR-2, catalyzed lacquer with a "water white" top coat, matte finish (low sheen) to match Architect's sample.
3. Filled Finish for Open-Grain Woods: Apply paste wood filler and wipe off excess. Tint filler to match stained wood.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition paneling to average prevailing humidity conditions in installation areas.

B. Before installing paneling, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Grade: Install paneling to comply with same grade as paneling to be installed.

B. Install paneling level, plumb, true, and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches. Install with no more than 1/16 inch in 96-inch vertical cup or bow and 1/8 inch in 96-inch horizontal variation from a true plane.

1. For flush paneling with revealed joints, install with variations in reveal width, alignment of top and bottom edges, and flushness between adjacent panels not exceeding 1/32 inch.

C. Anchor paneling to supporting substrate with concealed panel-hanger clips. Do not use face fastening unless otherwise indicated.

D. Coordinate with Operable Panel Partitions manufacturer for panel width, relationship to operable panel frames and panel-to-panel joints, and for location of blocking in the operable panel for attachment of wood veneer panels.

E. Complete finishing work specified in this Section to extent not completed at shop or before installation of paneling. Fill nail holes with matching filler where exposed.

1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are applied in shop.

F. Refer to Section 099300 "Staining and Transparent Finishing" for final finishing of installed paneling.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective paneling, where possible, to eliminate defects; where not possible to repair, replace paneling. Adjust for uniform appearance.

B. Clean paneling on exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064216

SECTION 066100 - GLASS-FIBER-REINFORCED POLYMER (GFRP) FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes factory-molded, glass-fiber-reinforced polymer fabrications for interior applications.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for steel framing, blocking, and bracing supporting glass-fiber-reinforced polymer fabrications.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, weights, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For adhesives, documentation including printed statement of VOC content.

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and assembly of glass-fiber-reinforced polymer fabrications.
3. Indicate requirements for joint treatment.

D. Samples: For each exposed product and for each color and texture specified.

1. Minimum size 6 inches square, representing actual product, color, and patterns.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to glass-fiber-reinforced polymer fabrications and to building structure.

3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, moldings, and other fixtures.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup of each type of glass-fiber-reinforced polymer fabrication.
2. Paint mockups to match final decoration scheduled or indicated and to comply with requirements specified in Section 099100 “Painting".
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Transport, lift, and handle units with care, avoiding excessive stress and preventing damage; use appropriate equipment.

B. Store products in manufacturer's unopened packaging until ready for installation, in a clean dry area protected from weather, moisture and damage; store units upright and not stacked unless permitted by manufacturer.

1.7 FIELD CONDITIONS

A. Environmental Conditions:

1. Do not deliver or install glass-fiber-reinforced polymer fabrications until building is enclosed, and wet work is complete.

B. Field Measurements: Where glass-fiber-reinforced polymer fabrications are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 GLASS-FIBER-REINFORCED POLYMER FABRICATIONS

A. Fabrications: Molded, glass-fiber-reinforced polymer units complying with ASTM C 1381/C 1381M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Custom Castings Northeast, Inc.
b. DEC Architectural Composites; Division of DEC Associates, Inc.

c. Duro Fiber Company, Inc.
d. First Class Building Products, Inc.
e. Stromberg Architectural Products, Inc.

B. Embedments: Cold-rolled steel channels with ASTM 653/A 653M, G60 hot-dip galvanized coating.

C. Finish: Polyurethane over polyester gel coat.

1. Surface: Smooth
2. Color: To match Architect's sample.

2.2 AUXILIARY MATERIALS

A. Adhesives: As recommended in glass-fiber-reinforced polymer fabrication manufacturer's written instructions and as follows:

1. Adhesive shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 2.04 FINISHES

A. Exposed Surfaces: Provide finishes and textures matching approved samples.

B. Directional grain, visible fibers, pinholes in gelcoat and other visible defects are not acceptable.

2.4 FABRICATION

A. Fabricate glass-fiber-reinforced polymer units with smooth-finished surfaces. Fabricate units in lengths and sizes indicated.

B. Embedments: Incorporate embedments into units to develop the full strength of glass-fiber-reinforced polymer fabrications. Cover embedments with not less than 3/16-inch thickness of glass-fiber-reinforced polymer composite.

C. Connection Hardware: Designed and fabricated to support and connect glass-fiber-reinforced polymer fabrications to hangers, support framing, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GLASS-FIBER-REINFORCED POLYMER INSTALLATION

A. Install glass-fiber-reinforced polymer fabrications level, plumb, true, and aligned with adjacent materials.

B. Attach glass-fiber-reinforced polymer fabrications to framing and substrates in accordance with manufacturer's recommendations.

C. Maintain uniform joint widths and alignment. Install clips, anchors, and all needed accessories. Installer to provide all templates and field dimensions to fabricator.

D. Temporary Supports and Bracing: Provide temporary supports and bracing as required to maintain position, stability, and alignment until permanent connections are made.

3.3 3.05 PATCHING & PAINTING

A. Patching Requirements: Patching will be permitted only if structural adequacy of unit and appearance of unit is not impaired. Obtain Architect's approval of all appearance patching. Remove and replace work that cannot be successfully patched.

B. Field paint all GFRP after installation.

3.4 CLEANING AND PROTECTION

A. Clean exposed surfaces materials and methods recommended by fabricator. Do not use chemical cleaning solutions. Remove and replace work that cannot be successfully cleaned. Prevent damage or deterioration of surfaces.

END OF SECTION 066100

SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

B. Related Requirements:

1. Section 079500 "Expansion Control" for foundation-wall expansion-joint assemblies that interface with waterproofing.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations for Waterproofing System: Obtain waterproofing materials, protection course, and molded-sheet drainage panels from single source from single manufacturer.

2.2 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet-waterproofing material manufacturer.

C. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

D. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

E. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch thick, predrilled at 9-inch centers.

F. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:

1. Thickness: [**1/8 inch**] [**1/4 inch**], nominal.
2. Thickness: 1/8 inch, nominal, for vertical applications; 1/4 inch, nominal, elsewhere.
3. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for protection course type.

2.3 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core[**and a polymeric film bonded to the other side**]; and with a vertical flow rate of 9 to 15 gpm per ft..

1. Products: Subject to compliance with requirements, [**available products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. American Hydrotech, Inc.; [**Hydrodrain 400**] [**or**] [**Hydrodrain 420**].
   b. Carlisle Coatings & Waterproofing Inc.; [**CCW MiraDRAIN 6000**] [**CCW MiraDRAIN 6000XL**] [**CCW MiraDRAIN 6200**] [**or**] [**CCW MiraDRAIN 6200XL**].
   c. Grace, W. R., & Co. - Conn.; [**Hydroduct 220**] [**or**] [**Hydroduct 660**].
   d. Protecto Wrap Company; Protecto Drain 2000-V.

2.4 INSULATION

A. Insulation, General: Comply with Section 072100 "Thermal Insulation."

B. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, [**square**] [**or**] [**shiplap**] edged.

1. Manufacturers: Subject to compliance with requirements, [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. DiversiFoam Products.
   b. Dow Chemical Company (The).
   c. Owens Corning Insulating Systems LLC.
   d. Pactiv Building Products.
   e. T. Clear Corporation, a subsidiary of Fin Pan Inc.

2. Type IV, 25-psi minimum compressive strength.
3. Type VI, 40-psi minimum compressive strength.
4. Type VII, 60-psi minimum compressive strength.
5. Type V, 100-psi minimum compressive strength.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the waterproofing.

1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

3.3 MOLDED-SHEET DRAINAGE-PANEL INSTALLATION

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install [**board insulation**] [**protection course**] before installing drainage panels.

3.4 INSULATION INSTALLATION

A. Install one or more layers of board insulation to achieve required thickness over waterproofed surfaces. Cut and fit to within 3/4 inch of projections and penetrations.

B. On vertical surfaces, set insulation units in adhesive or tape applied according to manufacturer's written instructions.

C. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.5 PROTECTION, REPAIR, AND CLEANING

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Protect installed [**board insulation**] [**and**] from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071326

SECTION 071900 - WATER REPELLENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes penetrating water-repellent treatments for the following vertical and horizontal surfaces:

1. Cast stone trim units.
2. Natural stone trim units.
3. Architectural concrete.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Installed water repellents shall comply with performance requirements indicated, as evidenced by reports based on Project-specific preconstruction testing of existing substrate assemblies by a qualified testing agency.

1. Select sizes and configurations of assemblies to adequately demonstrate capability of water repellents to comply with performance requirements.
2. In addition to verifying performance requirements, use test applications to verify manufacturer's written instructions for application procedure and optimum rates of product application to substrate assemblies.

1.4 ACTION SUBMITTALS

A. Preconstruction Testing : For each type of product indicated.

B. Samples: For each type of water repellent and substrate indicated, 12 by 12 inches in size, with specified water-repellent treatment applied to half of each Sample.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Applicator.

B. Product Certificates: For each type of water repellent, from manufacturer.

C. Preconstruction Testing Reports: For water-repellent-treated substrates.

D. Field quality-control reports.

E. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.

B. Mockups: Apply water repellent to each type of substrate required.

1. Locate each test application as directed by Owner.
2. Size: 10 sq. ft..
3. Final approval by Owner of water-repellent application will be from test applications.

1.7 PROJECT CONDITIONS

A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:

1. Ambient temperature is above 40 deg F and below 100 deg F and will remain so for 24 hours.
2. Substrate is not frozen and substrate-surface temperature is above 40 deg F and below 100 deg F.
3. Rain or snow is not predicted within 24 hours.
4. Not less than 24 hours have passed since surfaces were last wet.
5. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PENETRATING WATER REPELLENTS

A. Provide one of the following as recommended and approved for each substrate:

B. Siloxane, Penetrating Water Repellent: Clear, containing 10 percent or more solids of oligomerous alkylalkoxysiloxanes; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.

1. Products: Subject to compliance with requirements:

a. Chemical Products Industries, Inc.; CP-500W.
b. ChemMasters; Aquanil Plus WB.
c. Conproco Corporation; Conpro Shield MX.
d. Dayton Superior Corporation; Weather Worker WB Heavy Duty (J-27-WB).
e. Diedrich Technologies, Inc.; 303-C.
f. Euclid Chemical Company (The), an RPM company; Euco-Guard VOX.

g. H&C Concrete Care Products, Sherwin-Williams Company (The); H&C SX-7.
h. Price Research, Ltd.; Price Aqua Siloxane-#7.
i. Rainguard Products Company; MicroSeal.
j. SaverSystems; DEFY Water Repellent for Brick.
k. Specco Industries, Inc.; Waterstopper S-10 WB Siloxane.
l. Tamms Industries, Inc., Euclid Chemical Company (The); Baracade M.E.
m. Textured Coatings of America, Inc.; Rainstopper 1500..

C. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blend with 400 g/L or less of VOCs.

1. Products: Subject to compliance with requirements:

a. Advanced Chemical Technologies, Inc.; Sil-Act Dri-Treat.
b. BASF Construction Chemicals, LLC; White Roc 10 WB.
c. Conproco Corporation; Conpro Shield W20.
d. Degussa Corporation; Protectosil Aqua-Trete EM.
e. Fabrikem Manufacturing Ltd.; Fabrishield 900 Series.
f. Karnak Corporation; LL20.
g. Kryton International Inc., Kryton Group of Companies (The); Hydrostop WB.
h. L&M Construction Chemicals, Inc.; Hydropel WB.
i. LymTal International, Inc.; Iso-Flex 628.
j. OKON Co., Inc., Division of ZINSSER Co., Inc., an RPM company; S-40.
k. Pecora Corporation; KlereSeal 920-W.
l. PROSOCO, Inc.; Siloxane WB Concentrate.
m. SaverSystems; DEFY All-Purpose Heavy-Duty Water Repellent.
n. Sika Corporation, Inc.; Sikagard 701W.
o. Symons by Dayton Superior; Siloxane/Silane 10%.
p. Tamms Industries, Inc., Euclid Chemical Company (The); Chemstop WB Heavy Duty.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.

1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in three representative locations by method recommended by manufacturer.
2. Inspect for previously applied treatments that may inhibit penetration or performance of water repellents.
3. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
4. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions and as follows:

1. Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents according to ASTM E 1857.

B. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.

C. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.

D. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.

1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply a heavy-saturation coating of water repellent, on surfaces indicated for treatment, using 15 psi- pressure spray with a fan-type spray nozzle roller or brush to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.

C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.4 FIELD QUALITY CONTROL

A. Coverage Test: In the presence of Owner, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.

1. Notify Owner seven days in advance of the dates and times when surfaces will be tested.
2. Reapply water repellent until coverage test indicates complete coverage.

3.5 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Owner.

B. Comply with manufacturer's written cleaning instructions.

END OF SECTION 071900

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Foam-plastic board insulation.
2. Nailbase roof insulation for sheet metal roofing.
3. Glass-fiber blanket insulation.
4. Closed-cell spray foam polyurethane insulation.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for insulation installed in cavity walls and masonry cells.
2. Division 07 Section "Hot Fluid-Applied Rubberized Asphalt Waterproofing" for board insulation installed with waterproofing.
3. Division 07 Section(s) “Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing” for insulation specified as part of roofing construction.
4. Division 07 Section "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.
5. Division 09 Section(s) "Gypsum Board" for installation in metal-framed assemblies of insulation specified by referencing this Section.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. DiversiFoam Products.
   b. Dow Chemical Company (The).
   c. Owens Corning.
   d. Pactiv Building Products.

2. Type IV, 25 psi.

B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.2 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CertainTeed Corporation.
2. Guardian Building Products, Inc.
3. Johns Manville.
4. Knauf Insulation.
5. Owens Corning.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

C. Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

D. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:

1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

2.3 CLOSED-CELL SPRAY FOAM POLYURETHANE INSULATION

A. Closed Cell Spray Foam Insulation: two-component, closed cell polyurethane foam with a nominal density of 1.9 pcf, with the following minimum physical properties when cured:

1. Core Density: 1.9 - 2.2 lbs/ft3 when tested in accordance with ÅSTM D 1622.
2. Compressive Strength: 25 psi when tested in accordance with ÅSTM D 1621.
3. R-Value (aged): When tested in accordance with ASTM C 518:

   a. 6.9 per 1 inch.

4. Closed Cell Content: Greater than 90 percent when tested in accordance with ASTM D 2856.
5. Surface Burning Characteristics: Less than 25 when tested in accordance with ASTM E 84 and SDI less than 450 when tested in ASTM E 84.
6. Tensile Strength: 60 psi when tested in accordance with ÅSTM D 1623.
7. Moisture Vapor Transmission (permeance) when tested in accordance with ÅSTM E 96.

   a. 0.80 Perms at 1 inch.

8. Dimensional Stability: (7 days at 158 degrees F, 95 percent RH) less than 10 percent change in volume when tested in accordance with ÅSTM D 2126.
9. Air Leakage Rate: Less than 0.02 (L/s)/m2 when tested in accordance with ÅSTM E 283 and ÅSTM E 2178.
10. Fungi Resistance: Zero rating when tested in accordance with ÅSTM G 21.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.2 INSTALLATION OF BELOW-GRADE INSULATION

A. On vertical footing and foundation wall surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.

B. On horizontal surfaces under slabs, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

3.3 INSTALLATON OF INSULATION AT COMPOSITE METAL WALL PANELS

A. Install board insulation at composite metal wall panel construction where indicated on Drawings.

1. Coordinate installation of insulation boards with metal panel sub-framing. Use framing members to restrain insulation boards tight to air barrier surface where practicable. Use adhesives compatible with air barrier membrane.
2. Fit insulation to provide continuous thermal envelope.

3.4 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.

1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

3.5 INNSTALLATION OF CLOSED-CELL SPRAY FOAM POLYURETHANE INSULATION

A. Primer Application

1. Prepare surfaces and apply primer in accordance with manufacturer's instructions.
2. Apply primer to the properly prepared substrates in accordance with the manufacturer's instructions to achieve a minimum thickness of dry film thickness. Allow primer to cure 24 hours prior to application of spray polyurethane foam or other products.

B. Installation

1. Install in spray foam in accordance with manufacturer's instructions.
2. Spray polyurethane foam components shall be processed in accordance with instructions found on the manufacturers product datasheet.
3. Schedule application to anticipate climatic conditions prior to application to ensure highest quality foam and to maximize yield. All substrates to be sprayed must be dry at the time of application. Moisture in the form of rain, fog, frost, dew, or high humidity greater than 85 percent R.H is not permitted unless Contractor reviews means and methods of spraying with manufacturer's representative prior to installation. Use screens, masking and other precautions to prevent damage to adjacent areas from fugitive overspray.

END OF SECTION 072100

SECTION 072410 - POLYMER-BASED EXTERIOR SOFFIT FINISH SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Polymer-based exterior soffit finish system applied over exterior cement board.

B. Related Sections:

1. Division 5 Section "Cold-Formed Metal Framing" for exterior load-bearing and non-load-bearing metal framing.
2. Division 7 Section "Joint Sealants" for sealing joints in SYSTEM with elastomeric joint sealants.

1.3 SYSTEM DESCRIPTION

A. A non-load-bearing, exterior soffit finish system that consists of a mechanically attached cement board sheathing, an integrally reinforced base coat; and a textured protective finish coat.

1.4 PERFORMANCE REQUIREMENTS

A. Performance: Comply with the following:

1. Bond Integrity: Free from bond failure within system components or between system and supporting wall construction, resulting from exposure to fire, wind loads, weather, or other in-service conditions.
2. Weathertightness: Resistant to water penetration from exterior into interior of building that results in deterioration of thermal-insulating effectiveness or other degradation of assemblies behind it, including substrates, supporting wall construction, and interior finish.

B. System Performance: Provide system having physical properties and structural performance that comply with the following:

1. Abrasion Resistance: Sample cured for a minimum of 28 days; and showing no cracking, checking, or loss of film integrity after exposure to 528 quarts of sand when tested per ASTM D 968, Method A.
2. Absorption-Freeze Resistance: No visible deleterious effects and negligible weight loss after 60 cycles per EIMA 101.01.
3. Accelerated Weathering: Five samples per ICC-ES AC219 showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, delamination, or other characteristics that might affect performance as a wall cladding after testing for 2000 hours when viewed under 5 times magnification per ASTM G 153 or ASTM G 154.

4. Freeze-Thaw: No surface changes, cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination, or indications of delamination between components when viewed under 5 times magnification after 60 cycles per EIMA 101.01.
5. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch clean glass substrate, cured for 28 days, and showing no growth when tested per ASTM D 3273 and evaluated according to ASTM D 3274.
6. Tensile Adhesion: No failure in the system, adhesive, base coat, or finish coat when tested per ICC-ES AC219.
7. Water Resistance: Three samples, cured for 28 days and showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination after testing for 14 days per ASTM D 2247.
8. Wind-Driven-Rain Resistance: Resist wind-driven rain according to ICC-ES AC219.
9. Impact Resistance: Sample constructed, conditioned, and tested per EIMA 101.86; and meeting or exceeding the following:

    a. High Impact Resistance: 90 to 150 inch-lb.
10. Surface Burning: All components flame spread less than 25 and smoke developed less than 450 per ASTM E-84

1.5 SUBMITTALS

A. Product Data: For each type and component indicated.

B. Shop Drawings: Include plans, elevations, sections, details of components, details of penetration and termination, flashing details, joint locations and configurations, fastening and anchorage details including mechanical fasteners, and connections and attachments to other work.

C. Samples for Initial Selection: For each type of finish-coat color and texture indicated.

1. Include similar Samples of joint sealants and exposed accessories involving color selection.

D. Samples for Verification: 24-inch- square panels for each type of finish-coat color and texture indicated, prepared using same tools and techniques intended for actual work including a typical control joint filled with sealant of color selected.

1. Include sealant samples to verify color selected.

E. Qualification Data: For Installer and testing agency.

F. Material or Product Certificates: For cementitious materials and aggregates, and joint sealant, from manufacturer.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each water-/weather-resistive barrier, reinforcing mesh, and coating.

H. Compatibility and Adhesion Test Reports: For joint sealants from sealant manufacturer indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

I. Maintenance Data: To include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer who is certified in writing by manufacturer as qualified to install manufacturer's system using trained workers.

B. Source Limitations: Obtain system from single source from single manufacturer and from sources approved by manufacturer as compatible with system components.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution and set quality standards for fabrication and installation.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.

B. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Maintain ambient temperatures above 40 deg F for a minimum of 24 hours before, during, and after adhesives or coatings are applied. Do not apply adhesives or coatings during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit system to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify actual dimensions required for prefabricated panels by field measurements before fabrication.

1.9 COORDINATION

A. Coordinate installation of system with related Work specified in other Sections to ensure that wall assemblies, flashing, trim, joint sealants, windows, and doors, are protected against damage from the effects of weather, age, corrosion, moisture, and other causes. Do not allow water to penetrate behind flashing and barrier coating of system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Finestone; Degussa Wall Systems, Inc.
2. Parex, Inc.; a brand of ParexLahabra, Inc.
3. Sto Corp.

2.2 MATERIALS

A. Compatibility: Provide adhesive, fasteners, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by manufacturer for Project.

B. Exterior Cement Board: Not less than 7/16-inch**-** thick, fiber cement board complying with ASTM C 1186, Type A, for exterior applications. Build up layers of thinner material at curved sections as required to form a smooth radius to achieve a total thickness of not less than 7/16-inch.

1. Fasteners: Wafer-head or flat-head steel drill screws complying with ASTM C 954, with an organic-polymer coating or other corrosion-protective coating having a salt-spray resistance of more than 500 hours per ASTM B 117.

a. Size and Length: As recommended by sheathing manufacturer for type and thickness of sheathing board to be attached.

C. Primer/Sealer: Manufacturer's standard substrate conditioner designed to seal substrates from moisture penetration and to improve the bond between substrate of type indicated and adhesive used for application of insulation.

D. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberized-asphalt and polyethylene-film composite sheet or tape and primer; manufacturer's standard or product recommended in writing by manufacturer.

E. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other system materials, made from continuous multiend strands with retained mesh tensile strength of not less than 120 lbf/in. per ASTM E 2098; complying with ASTM D 578 and the following:

1. Standard-Impact Reinforcing Mesh: Not less than 4.5 oz./sq. yd.
2. Strip Reinforcing Mesh: Not less than 3.75 oz./sq. yd.
3. Detail Reinforcing Mesh: Not less than 4.5 oz./sq. yd.
4. Corner Reinforcing Mesh: Not less than 7.2 oz./sq. yd.

F. Base-Coat Materials: Manufacturer's standard mixture complying with the following:

1. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.

G. Waterproof Adhesive/Base-Coat Materials: Manufacturer's standard waterproof formulation complying with one of the following:

1. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
2. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.

H. Primer: Manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.

I. Finish-Coat Materials: Manufacturer's standard acrylic-based coating with enhanced mildew resistance complying with the following:

1. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, and fillers used with stone particles for embedding in finish coat to produce an applied-aggregate finish.

a. Aggregate: Marble chips of size and color as selected by Architect from manufacturer's full range.

2. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.
3. Colors: As selected by Architect from manufacturer's full range.

J. Water: Potable.

K. Mechanical Fasteners: Manufacturer's standard corrosion-resistant fasteners:

1. For attachment, provide manufacturer's standard fasteners suitable for substrate.

L. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with system manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.

1. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
2. Expansion Joint: Prefabricated, one-piece V profile; designed to relieve stress of movement.

2.3 MIXING

A. General: Comply with system manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by manufacturer. Mix materials in clean containers. Use materials within time period specified by system manufacturer or discard.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the system.

B. Examine roof edges, wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where system will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Begin coating application only after surfaces are dry.
2. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Protect contiguous work from moisture deterioration and soiling caused by application of system. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.

B. Protect substrates and construction behind them from inclement weather during installation. Prevent penetration of moisture behind system and deterioration of substrates.

C. Prepare and clean substrates to comply with system manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

1. Verify suitability of substrate by performing bond and moisture tests recommended by system manufacturer.

3.3 EXTERIOR CEMENT-BOARD INSTALLATION

A. Exterior Cement Board: Install on metal framing to comply with cement-board manufacturer's written instructions and evaluation report acceptable to authorities having jurisdiction. Install board with steel drill screws spaced no more than 8 inches o.c. along framing with perimeter fasteners at least 3/8 inch but less than 5/8 inch from edges of boards.

3.4 SYSTEM INSTALLATION, GENERAL

A. Comply with system manufacturer's written instructions for installation of system as applicable to each type of substrate indicated.

3.5 SUBSTRATE PROTECTION APPLICATION

A. Primer/Sealer: Apply over substrates to protect substrates from degradation and where required by system manufacturer for improving adhesion of insulation to substrate.

B. Waterproof Adhesive/Base Coat: Apply at exterior soffits to protect substrates from degradation.

C. Flexible-Membrane Flashing: Install over weather-resistive barrier, applied and lapped to shed water; seal at openings, penetrations, terminations, and where indicated by system manufacturer's written instructions to protect wall assembly from degradation. Prime substrates, if required, and install flashing to comply with system manufacturer's written instructions and details.

3.6 TRIM INSTALLATION

A. Trim: Apply trim accessories at perimeter of SYSTEM, at expansion joints and elsewhere as indicated, according to system manufacturer's written instructions. Coordinate with installation of insulation.

1. Expansion Joint: Use where indicated on Drawings.
2. Casing Bead: Use at other locations.

3.7 BASE-COAT INSTALLATION

A. Base Coat: Apply to exposed surfaces of substrate minimum thickness recommended in writing by system manufacturer, but not less than 1/16-inch dry-coat thickness.

B. Reinforcing Mesh: Embed reinforcing mesh in wet base coat to produce wrinkle-free installation with mesh continuous at corners and overlapped not less than 2-1/2 inches or otherwise treated at joints to comply with ASTM C 1397 and system manufacturer's written instructions. Do not lap reinforcing mesh within 8 inches of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.

C. Additional Reinforcing Mesh: Apply strip reinforcing mesh around openings extending 4 inches beyond perimeter. Apply additional 9-by-12-inch strip reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch- wide strip reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches on each side of corners.

1. At aesthetic reveals, apply strip reinforcing mesh not less than 8 inches wide.

2. Embed strip reinforcing mesh in base coat before applying first layer of reinforcing mesh.

3.8 FINISH-COAT INSTALLATION

A. Primer: Apply over dry base coat according to system manufacturer's written instructions.

B. Finish Coat: Apply over dry primed base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by system manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.

1. Texture: As selected by Architect from manufacturer's full range.
2. Embed aggregate in finish coat according to system manufacturer's written instructions to produce a uniform applied-aggregate finish of color and texture matching approved sample.

C. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by system manufacturer.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections: For the following:

1. According to ICC-ES AC212.

C. Remove and replace system where test results indicate that system does not comply with specified requirements.

D. Prepare test and inspection reports.

3.10 CLEANING AND PROTECTION

A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive SYSTEM coatings.

END OF SECTION 07241

SECTION 072713 - MODIFIED BITUMINOUS SHEET AIR/VAPOR/WATER BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes self-adhering, vapor-permeable, modified bituminous sheet air barriers.

B. Related Requirements:

1. Division 06 Section "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.

1.3 DEFINITIONS

A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

B. Vapor-Barrier Material: A primary element that is intended to control the rate of diffusion of water vapor into a building assembly.

C. Water Resistive Barriers: Materials which are primarily designed to be used to keep liquid water from entering the building enclosure.

D. Air /Water Barrier: A combined air barrier and water resistive barrier provided in a single material, with minimum vapor permeance of more than 1 perm.

E. Air/ Water Barrier Assembly: The collection of materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control the movement of air and liquid water through the wall.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.2: For air-barrier products, documentation including printed statement of VOC content.

C. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
2. Include details of interfaces with other materials that form part of air barrier.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by the Installer, who work on Project.

B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with air barrier.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

B. Mockups: Build mockups to set quality standards for materials and execution.

1. Build integrated mockups of exterior wall assembly as shown on Drawings, incorporating backup wall construction, external cladding, curtainwall, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.

a. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups. Separate tests to be performed on masonry wall assembly and on aluminum composite metal wall panel assembly.

B. Mockup Testing: Air-barrier assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.

1. Qualitative Air-Leakage Testing: Mockups will be tested for evidence of air leakage according to ASTM E 1186, chamber pressurization or depressurization with smoke tracers.
2. Quantitative Air-Leakage Testing: Mockups will be tested for air leakage according to ASTM E 783.
3. Adhesion Testing: Mockups will be tested for minimum air-barrier adhesion of 16 lbf/sq. in. according to ASTM D 4541.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Protect stored materials from direct sunlight.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.

1. Protect substrates from environmental conditions that affect air-barrier performance.
2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

2.2 PERFORMANCE REQUIREMENTS

A. General: Air/Water barrier shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E 783.

2.3 SELF-ADHERING SHEET AIR BARRIER

A. Modified Bituminous Sheet: 40-mil- thick, self-adhering sheet consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick, cross-laminated polyethylene film with release liner on adhesive side. Provide high-temperature resistant sheet for use under metal copings.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle Coatings & Waterproofing Inc.; CCW-705.
b. Grace, W. R. & Co. - Conn.; Perm-A-Barrier Wall Membrane.
c. Henry Company; Blueskin SA.
d. Meadows, W. R., Inc.; SealTight Air-Shield.

2. Physical and Performance Properties:

a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
b. Tensile Strength: Minimum 250 psi; ASTM D 412, Die C.
c. Ultimate Elongation: Minimum 200 percent; ASTM D 412, Die C.
d. Puncture Resistance: Minimum 40 lbf; ASTM E 154.
e. Water Absorption: Maximum 0.15 percent weight gain after 48-hour immersion at 70 deg F; ASTM D 570.
f. Vapor Permeance: Maximum 0.05 perm; ASTM E 96/E 96M, Water Method.

2.4 ACCESSORY MATERIALS

A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier membrane.

B. Primer: Liquid waterborne primer recommended for substrate by air-barrier material manufacturer.

C. Counterflashing Strip: Modified bituminous 40-mil- thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil- thick, cross-laminated polyethylene film with release liner backing.

D. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

E. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.

F. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.

G. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0250 inch thick, and Series 300 stainless-steel fasteners.

H. Modified Bituminous Transition Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.

I. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Division 07 Section "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
2. Verify that concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

G. Bridge and cover isolation joints discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with overlapping modified bituminous strips.

H. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

I. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 INSTALLATION

A. General: Install modified bituminous sheets and accessory materials according to air-barrier manufacturer's written instructions and according to recommendations in ASTM D 6135.

1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous air-barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F.

B. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.

C. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations with termination mastic and according to ASTM D 6135.

D. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.

1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

E. Apply and firmly adhere modified bituminous sheets horizontally over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.

1. Apply sheets in a shingled manner to shed water without interception by any exposed sheet edges.
2. Roll sheets firmly to enhance adhesion to substrate.

F. CMU: Install air-barrier sheet horizontally against the CMU beginning at base of wall. Align top edge of air-barrier sheet immediately below protruding masonry ties or joint reinforcement or ties, and firmly adhere in place.

1. Overlap horizontally adjacent sheets a minimum of 2 inches and roll seams.
2. Apply overlapping sheets with bottom edge slit to fit around masonry reinforcing or ties. Roll firmly into place.
3. Seal around masonry reinforcing or ties and penetrations with termination mastic.
4. Continue the membrane into all openings in the wall, such as doors and windows, and terminate at points to maintain an airtight barrier that is not visible from interior.

G. Seal top of through-wall flashings to air-barrier sheet with an additional 6-inch- wide, counterflashing strip.

H. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

I. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.

1. Coordinate air-barrier installation with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

J. Connect and seal exterior wall air-barrier membrane continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

K. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact. At curtainwall frames, seal transition strip into glazing stop.

1. Modified Bituminous Transition Strip: Roll firmly to enhance adhesion.

L. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.

M. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

N. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.

O. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

P. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Continuous structural support of air-barrier system has been provided.
3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
4. Site conditions for application temperature and dryness of substrates have been maintained.
5. Maximum exposure time of materials to UV deterioration has not been exceeded.
6. Surfaces have been primed.
7. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
8. Termination mastic has been applied on cut edges.
9. Air barrier has been firmly adhered to substrate.
10. Compatible materials have been used.
11. Transitions at changes in direction and structural support at gaps have been provided.
12. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
13. All penetrations have been sealed.

C. Tests: As determined by Owner's testing agency from among the following tests:

1. Qualitative Air-Leakage Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186, chamber pressurization or depressurization with smoke tracers.
2. Quantitative Air-Leakage Testing: Air-barrier assemblies will be tested for air leakage according to ASTM E 783.
3. Adhesion Testing: Air-barrier assemblies will be tested for minimum air-barrier adhesion of 16 lbf/sq. in. according to ASTM D 4541 for each 600 sq. ft. of installed air barrier or part thereof.

D. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 072713

SECTION 074213 - METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concealed-fastener, lap-seam metal wall panels.

B. Related Sections:

1. Division 05 Section "Cold-Formed Metal Framing" for support framing, including girts, studs, and bracing.
2. Division 07 Section "Air Barriers" for continuous air barrier systems.
3. Division 07 Section "Composite Wall Panels" for metal-faced composite wall panels.
4. Division 07 Section "Sheet Metal Flashing and Trim" for flashing and other sheet metal work that is not part of metal wall panel assemblies.

1.3 DEFINITION

A. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight wall system.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Design metal wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

E. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592:

1. Wind Loads: Determine loads based on the following minimum design wind pressures:

   a. Uniform pressure of 20 lbf/sq. ft., acting inward or outward.

2. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 of the span.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of wall panel and accessory.

B. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop- and field-assembled work.

1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

   a. Flashing and trim.
   b. Anchorage systems.

C. Samples for Initial Selection: For each type of metal wall panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.
2. Include manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each sealant exposed to view.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Wall Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal wall panel accessories.
2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: 12-inch- long Samples for each type of accessory.

E. Delegated-Design Submittal: For metal wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and wall-mounted items. Show the following:

1. Wall panels and attachments.
2. Girts.
3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
4. Penetrations of wall by pipes and utilities.

B. Qualification Data: For Installer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

D. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal wall panels to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

C. Source Limitations: Obtain each type of metal wall panel from single source from single manufacturer.

D. Fire-Resistance Ratings: Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

E. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal wall panel Installer, metal wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal wall panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal wall panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.

7. Review temporary protection requirements for metal wall panel assembly during and after installation.
8. Review wall panel observation and repair procedures after metal wall panel installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.

B. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal wall panel for period of metal wall panel installation.

E. Protect foam-plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.10 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication, and indicate measurements on Shop Drawings.

1.11 COORDINATION

A. Coordinate metal wall panel assemblies with rain drainage work, flashing, trim, and construction of girts, studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including rupturing, cracking, or puncturing.
    b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
2. Surface: Smooth, flat finish.
3. Exposed Coil-Coated Finish:

    a. Fluoropolymer: AAMA 621. Three or Four-coat fluoropolymer finish as required to obtain selected color. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    b. Color: Valspar Industrial Coating SL9A300 Fluropon Classic Champagne Metallic with clear coat.

4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, fully annealed.

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.

    a. Run grain of directional finishes with long dimension of each piece.
    b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

c. Directional Satin Finish: No. 4.

3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

C. Panel Sealants:

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.2 FIELD-INSTALLED THERMAL INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft., with maximum flame-spread index of 75 and smoke-developed index of 450.

2.3 MISCELLANEOUS METAL FRAMING

A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G60 hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

B. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch nominal thickness.

C. Zee Clips: 0.079-inch nominal thickness.

D. Base or Sill Angles and Channels: 0.079-inch nominal thickness.

E. Cold-Rolled Furring Channels: Minimum 1/2-inch- wide flange.

1. Nominal Thickness: 0.064 inch.
2. Depth: 3/4 inch.
3. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch nominal thickness.
4. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

F. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, and depth required to fit insulation thickness indicated.

1. Nominal Thickness: As required to meet performance requirements.

G. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.4 MISCELLANEOUS MATERIALS

A. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.5 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

A. General: Provide factory-formed metal wall panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Flush-Profile, Concealed-Fastener Metal Wall Panels at inside face of parapet walls: Formed with vertical panel edges and flat pan between panel edges; with flush joint between panels.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Alcoa Architectural Products (USA).
    b. Berridge Manufacturing Company.
    c. CENTRIA Architectural Systems; IW-10A

2. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch nominal thickness.

    a. Exterior Finish: 4-coat fluoropolymer.
    b. Color: Valspar Industrial Coating SL9A300 Fluropon Classic Champagne Metallic with clear coat..

3. Panel Coverage: 12 inches.
4. Panel Height: 0.875 inch.

C. Creased-Rib-Profile, Concealed-Fastener Metal Wall Panels at mechanical penthouse and where indicated. Horizontal application, formed with raise trapezoidal ribs at 4” o.c., with concealed attachment clips that allow for thermal movement.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Alcoa Architectural Products (USA).
    b. ATAS International, Inc.
    c. CENTRIA Architectural Systems; Concept Series CS-660.

2. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch nominal thickness.

    a. Exterior Finish: 4-coat fluoropolymer.
    b. Color: Valspar Industrial Coating SL9A300 Fluropon Classic Champagne Metallic with clear coat.

3. Panel Coverage: 16 inches.
4. Panel Height: 0.875 inch.

2.6 WALL LOUVER UNITS

A. Wall Louvers, General: Metal louvers, designed to integrate with metal wall panel profile and secondary support system without receptor channels or other flashing, of types and performance indicated.

B. Horizontal, Drainable-Blade Fixed Louver:

1. Louver Size: As indicated on Drawings.
2. Louver Depth: Match metal wall panel system depth.
3. Free Area: 30 percent.

C. Base Metal and Finish:

1. Match metal wall panel base metal and finish.

D. Louver Screens: Mounted in removable aluminum frame.

1. Bird Screen: 1/2-inch (12 mm) mesh aluminum, crimped.

2.7 ACCESSORIES

A. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

B. Flashing and Trim: Formed from 0.018-inch minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

2.8 FABRICATION

A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, and that will minimize noise from movements within panel assembly.

E. Fabricate mitered corners without exposed trim.

F. Provide louver fins to match adjacent metal panel profile for wall louvers at penthouse.

G. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.

a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.9 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
3. Verify that weather-resistant sheathing paper has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
4. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

B. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754 and metal wall panel manufacturer's written recommendations.

3.3 THERMAL INSULATION INSTALLATION

A. Board Insulation: Extend insulation in thickness indicated to cover entire wall. Comply with installation requirements in Division 07 Section "Thermal Insulation."

1. Erect insulation horizontally and hold in place with Z-shaped furring members spaced 24 inches o.c. Attach furring members to substrate with screws spaced 24 inches o.c.
2. Retain insulation in place by metal clips and straps or integral pockets within panels, spaced at intervals according to insulation manufacturer's instructions. Maintain cavity width between insulation and metal liner panel of dimension indicated.

3.4 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Commence metal wall panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. Flash and seal metal wall panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
4. Install screw fasteners in predrilled holes.

5. Locate and space fastenings in uniform vertical and horizontal alignment.
6. Install flashing and trim as metal wall panel work proceeds.
7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
8. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
9. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
10. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.

B. Fasteners:

1. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.
2. Stainless-Steel Wall Panels: Use stainless-steel fasteners.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

E. Lap-Seam Metal Wall Panels: Fasten metal wall panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal wall panels.
3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
5. Provide sealant tape at lapped joints of metal wall panels and between panels and protruding equipment, vents, and accessories.
6. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps; on side laps of nesting-type panels; on side laps of corrugated nesting-type, ribbed, or fluted panels; and elsewhere as needed to make panels weathertight.
7. At panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

F. Zee Clips: Provide Zee clips of size indicated or, if not indicated, as required to act as standoff from subgirts for thickness of insulation indicated. Attach to subgirts with fasteners.

3.5 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.

B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213

SECTION 074243 – METAL COMPOSITE MATERIAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes metal composite material wall panels over multi-component framed wall system: Aluminum-faced composite panels applied as exterior pressure equalized rain screen (PERS) system over wall framing with exterior sheathing, an applied membrane that provides air, moisture, and water vapor control, and insulation applied over the air/water barrier membrane.

1. Metal composite material wall panel installation specified in this Section includes secondary metal subgirt framing and mounting clips for panel attachment.
2. Panel mounting system includes shims, furring, fasteners, internal gaskets, flashing and seals to air/water barrier and protective film as required for a complete installation.
3. System to include panels formed from matching materials to sizes and shapes indicated including parapet copings, column or beam wraps, cornices, soffit, fascias, sills, and filler items as indicated or as necessary to provide a complete enclosure.

B. Related Sections:

1. Division 05 Section "Cold-Formed Metal Framing" for cold-formed metal framing supporting metal-faced composite wall panels.
2. Division 07 Section “Thermal Insulation” for foam-plastic board insulation installed behind composite wall panels.
3. Division 07 Section “Modified Bituminous Sheet Air/Vapor Barriers” for membrane air/vapor barrier.
4. Division 07 Section "Metal Wall Panels" for through-the-face-fastened metal wall panels and metal soffit and fascia panels.
5. Division 07 Section "Sheet Metal Flashing and Trim" for field-formed flashings and other sheet metal work not part of metal-faced composite wall panel assemblies.
6. Division 07 Section "Joint Sealants" for field-applied sealants for joints located on horizontal surfaces or to dissimilar adjacent materials.

1.3 DEFINITION

A. Metal Composite Material Wall Panel Assembly: Aluminum-faced composite wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Metal Composite Material Wall Panel Assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Design metal-faced composite wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Secondary Supports Design: Design, fabricate, and install secondary structural components of the metal cladding system with a factor of safety not less than 1.5 (basis for design calculations shall be 1.5 times the maximum design wind pressure), such that failure of any panel component shall not occur at less than 1.5 times the maximum design wind pressure. Failure is defined as breakage, component disengagement, or permanent distortion.

C. Pressure Equalization and Airflow: The horizontal joint shall be designed to minimize water penetration through the rainscreen while permitting air to flow freely through the rainscreen element thus venting the cavity between the rainscreen and the air and water barrier backup. To achieve this performance the product must pass AAMA 508-07 "Voluntary Test Method and Specifications for Pressure Equalized Rain Screen Wall Cladding Systems" @ 15 psf pressure difference ***with an imperfect air barrier***. Mockup specimen shall be 96" x 96". Testing with a fully sealed air barrier is not acceptable.

D. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

E. Water Penetration Under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

F. Structural Performance: Provide metal-faced composite wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:

1. Wind Loads: Determine loads based on the following minimum design wind pressures:

a. Uniform pressure of 20 lbf/sq. ft., acting inward or outward.
b. Uniform pressure as indicated on Drawings.

2. Deflection Limits: Metal-faced composite wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/175 of the span at the perimeter and 1/60 of the span anywhere in the panel.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

H. Composite wall panels shall have a *flame spread index* of not more than 25 and a smoke-developed index of not more than 450 when tested as an assembly in the maximum thickness intended for use in accordance with ASTM E 84 or UL 723.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, metal composite material panel Installer, structural-support Installer, and installers whose work interfaces with or affects metal composite material panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal composite material panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal composite material panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal composite material panel assembly during and after installation.
8. Review procedures for repair of panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal composite material panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim and anchorage, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of metal composite material panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Composite Material Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal composite material panel accessories.

E. Delegated-Design Submittal: For Metal Composite Material Wall Panel Assembly to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal composite material panels to include in maintenance manuals.

1.9 QUALITY ASSURANCE

A. Source Limitations: Obtain all components of Metal Composite Material Wall Panel Assembly from single source.

B. Panel fabricator/installer shall assume undivided responsibility for all components of the exterior panel system from face of air/water barrier out.

C. Shop Drawings shall be prepared by the Fabricator of the PERS systems.

D. Coordination: Panel system shop drawings shall be coordinated with references to benchmark elevations and horizontal controls provided by GC/CM with all the other adjacent exterior wall trades drawings to including but not limited to:

1. Exterior Studs and sheathing: 16 ga min to avoid fastener pullover.
2. Other Wall Cladding systems: Brick, Precast, Stone or other metal systems etc.
3. Fenestration: Windows, storefront and curtain walls, louvers.
4. Air/water barriers and flashing to openings, roofing and adjacent materials.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal-faced composite wall panels, and other manufactured items so as not to be damaged or deformed. Package metal-faced composite wall panels for protection during transportation and handling.

B. Unload, store, and erect metal-faced composite wall panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Store metal-faced composite wall panels vertically, covered with suitable weathertight and ventilated covering. Store metal-faced composite wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal-faced composite wall panels in contact with other materials that might cause staining, denting, or other surface damage. Do not allow storage space to exceed 120 deg F.

D. Retain strippable protective covering on metal-faced composite wall panel for period of panel installation.

1.11 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal-faced composite wall panels to be performed according to manufacturer's written instructions and warranty requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal-faced composite wall panel fabrication and indicate measurements on Shop Drawings.

1.12 COORDINATION

A. Coordinate metal-faced composite wall panel assemblies with rain drainage work, flashing, trim, and construction of studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Surface: Smooth, flat finish.
2. Exposed Coil-Coated Finishes:

a. Fluoropolymer: AAMA 620. Three or Four-coat fluoropolymer finish as required to obtain selected color. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 MISCELLANEOUS MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.

B. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. All fasteners to be stainless steel.

2.3 METAL-FACED COMPOSITE WALL PANELS

A. General: Provide factory-formed and -assembled, metal-faced composite wall panels fabricated from two metal facings bonded, using no glues or adhesives, to solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment system components and accessories required for weathertight system.

B. Aluminum-Faced Composite Wall Panels: Formed with minimum 0.020-inch- thick, coil-coated aluminum sheet facings.

1. Panel Thickness: 0.157 inch.
2. Exterior Finish: Fluoropolymer.

a. Color: Valspar Industrial Coating 431A893 Fluropon Bone White with clear coat.

3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Alcan Composites USA Inc.; Alucobond.
b. Alcoa Inc.; Reynobond PE.
c. ALPOLIC, Division of Mitsubishi Chemical America, Inc.; ALPOLIC.

C. Fabricator: Metal Composite Material Wall Panel Assembly

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Allied Metal; ESTOLGA rain Screen system
b. Altech Panel Systems; Accu-Trac® DS
c. Metal Sales & Service, Inc.; Metalwërks® Arcwall ACM Rain Screen PERS

2.4 SECONDARY METAL FRAMING

A. Miscellaneous Framing Components, General: Cold-formed metallic-coated steel sheet, ASTM C 645, Grade 50, with ASTM A 653/A 653M, G90 hot-dip galvanized zinc coating.

1. 'Z' Girts: 0.053 inch minimum.
2. Hat Channels: 0.053 inch minimum.
3. Sill Channels: 0.053 inch minimum.

B. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B 209.
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.

2.5 ACCESSORIES

A. Wall Panel Accessories: Provide components required for a complete metal-faced composite wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal-faced composite wall panels unless otherwise indicated.

1. Sealants within the panel system shall be as per manufacturer's standards to meet performance requirements.
2. Internal baffles: Reticulated 50 PPI polyurethane foam
3. Internal Flashing: sheet metal flashing which may be required at base or penetration conditions will be produced in the same material finish as the adjacent panels but will be provided in minimum .040" thickness or 24 ga 304 2B Stainless steel.
4. Coping: Wall copings will be produced with the same material as the wall panel system unless otherwise noted. Sheet metal flashing extensions will be acceptable in non-viewing areas in accordance with Manufacturer's recommended details.
5. Furring: Wall panels will be attached to minimum 16 ga. Type 304 stainless steel or .125" thick aluminum furring.
6. Fasteners: Panel fasteners shall be stainless steel or other corrosion resistant coated fastener for panel attachment in size and spacing as dictated by structural review.

2.6 FABRICATION

A. General: Fabricate and finish metal-faced composite wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal-faced composite wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.

C. Metal-Faced Composite Wall Panels: Factory form panels in a continuous process with no glues or adhesives between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.

1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
2. Fabricate panels with sharply cut edges, with no displacement of face sheets or protrusion of core material.
3. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant or bond tape.
4. Dimensional Tolerances:

    a. Panel Bow: 0.8 percent maximum of panel length or width.
    b. Squareness: 0.25 inch maximum.

D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal-faced composite wall panel manufacturer.

   a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal-faced composite wall panel manufacturer for application, but not less than thickness of metal being secured.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal-faced composite wall panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal-faced composite wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal-faced composite wall panel manufacturer.
3. Verify that weather-resistant sheathing paper has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal-faced composite wall panels to verify actual locations of penetrations relative to seam locations of panels before panel installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 METAL-FACED COMPOSITE WALL PANEL INSTALLATION

A. General: Install metal-faced composite wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Commence metal-faced composite wall panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
2. Shim or otherwise plumb substrates receiving metal-faced composite wall panels.
3. Flash and seal metal-faced composite wall panels at perimeter of all openings. Do not begin installation until weather barrier and flashings that will be concealed by panels are installed.
4. Install flashing and trim as metal-faced composite wall panel work proceeds.
5. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
6. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.

B. Fasteners:

1. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal-faced composite wall panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal-faced composite wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.

1. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

E. Attachment System Installation, General: Install attachment system required to support metal-faced composite wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
2. Do not begin installation until weather barrier and flashings that will be concealed by composite panels are installed.

F. Rainscreen-Principle Installation: Provide manufacturer's standard pressure-equalized, rainscreen-principle system with vertical channel that provides support and complete secondary drainage system, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by manufacturer. Attach wall panels by engaging horizontal support pins into notches in vertical channels and into flanges of wall panels. Leave horizontal and vertical joints with open reveal.

1. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
2. Do not apply sealants to joints unless otherwise indicated on Drawings.

3.3 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal-faced composite wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal-faced composite wall panel units within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal-faced composite wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal-faced composite wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.

B. After metal-faced composite wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal-faced composite wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074243

SECTION 075216 - STYREN-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing.
2. Vapor retarder.
3. Roof insulation.
4. EFVM detection system.

B. Related Sections:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 077110 “Vegetated Roof Modules” for modular green roof tray system and integrated roof pedestal/paver system on root barrier over SBS modified bituminous membrane roofing.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
4. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F, measured at the mop cart or mechanical spreader immediately before application.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.

D. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

E. Energy Performance: Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
2. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings:

1. For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   a. Base flashings and membrane terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
   d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

2. For EFVM Detection System:
   a. Show leak location grid layout.
   b. Location of access enclosure.
   c. Wiring path from leak location grid to access enclosure.
   d. Termination block and Sub D connector wiring diagram in access enclosure.
   e. Location and size of roof penetrations.
   f. Location of roof drains and details of electrical guard circuits surrounding drains.
   g. Show sequence of installation or operations.

D. Samples for Verification: For the following products:

1. Sheet roofing materials, including base sheet, roofing membrane sheet, membrane cap sheet and flashing sheet, of color specified.
2. Roof insulation.
3. Walkway pads or rolls.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer manufacturer and testing agency.

B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of complying with performance requirements.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

D. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.

E. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

C. EVFM System Installer and Survey Company Qualifications: A qualified firm that is approved, authorized, or licensed by EVFM system manufacturer to install manufacturer's product and perform leak detection surveys.

D. Source Limitations: Obtain components, including roof insulation and vapor barriers, for membrane roofing system from same manufacturer as membrane roofing.

E. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

F. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review coordination and sequence of construction related to the EFVM leak detection system and the vegetated roof modules system.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
5. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
6. Review structural loading limitations of roof deck during and after roofing.
7. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, EFVM system, vegetated roof modules system, and condition of other construction that will affect roofing system.
8. Review governing regulations and requirements for insurance and certificates if applicable.

9. Review temporary protection requirements for roofing system during and after installation.
10. Review roof observation and repair procedures after roofing installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

E. Protect EFVM electronic equipment and sensing and detection devices against damage from dust and moisture.

1.10 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.
2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, and walkway products, for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SBS-MODIFIED ASPHALT-SHEET MATERIALS

A. SBS-Modified Bituminous Membrane Roofing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Firestone Building Products.
b. GAF Materials Corporation.
c. Johns Manville.

2.2 BASE-SHEET MATERIALS

A. Base Sheet: ASTM D 6163, Type I or II, Grade S, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

2.3 CAP SHEET

A. Granule-Surface Roofing Membrane Cap Sheet: ASTM D 6163, Grade G, Type II, SBS-modified asphalt sheet (reinforced with glass fibers); granular surfaced; suitable for application method specified.

1. Cap sheet to have minimum Solar Reflectance Index (SRI) equal to or greater than 78.

B. Products:

1. Firestone Building Products: Ultrawhite.
2. GAF Materials Corporation: Energy Cap.
3. Johns Manville: GlasKap.

2.4 BASE FLASHING SHEET MATERIALS

A. Backer Sheet: ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers); smooth surfaced; suitable for application method specified.

B. Granule-Surfaced Flashing Sheet: ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers); granular surfaced; suitable for application method specified, and as follows:

1. Granule Color: White.
2. Granule-Surfaced Flashing Sheet to have minimum Solar Reflectance Index (SRI) equal to or greater than 78.

2.5 AUXILIARY ROOFING MEMBRANE MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesive: 80 g/L.
    f. Other Adhesives: 250 g/L.
    g. Nonmembrane Roof Sealants: 300 g/L.
    h. Sealant Primers for Nonporous Substrates: 250 g/L.
    i. Sealant Primers for Porous Substrates: 775 g/L.

B. Asphalt Primer: ASTM D 41.

C. Roofing Asphalt: ASTM D 312, Type III or IV as recommended by roofing system manufacturer for application.

D. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application.

E. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

G. Metal Flashing Sheet: As specified in Section 076200 "Sheet Metal Flashing and Trim."

H. Roofing Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 sieve and 98 percent of mass retained on No. 40 sieve, color to match roofing membrane.

I. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

2.6 SUBSTRATE BOARDS

A. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch thick.

1. Apply over metal roof decks as a substrate for vapor retarder.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.7 VAPOR RETARDER

A. Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm; cold applied, with slip-

resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

1. Apply over concrete decks and on gypsum board substrates on metal decks.

2.8 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class I, Grade 3, felt or glass-fiber mat facer on both major surfaces.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.9 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

C. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.

D. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

E. Insulation Cant Strips: ASTM C 728, perlite insulation board.

F. Wood Nailer Strips: Comply with requirements in Section 061053 "Miscellaneous Rough Carpentry."

G. Tapered Edge Strips: ASTM C 728, perlite insulation board.

H. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch thick.

2.10 ELECTRONIC FIELD VECTOR MAPPING (EFVM) DETECTION GRID

A. General: Furnish and install complete leak detection system to facilitate EFVM surveys, including grounding grid and test panel connector box, perimeter conductor wire, electrical cable, and related accessories as recommended by the system manufacturer.

1. Detection grounding grid to be installed on top of cover board and below SBS modified roof membrane. Manufacturer to insure compatibility of grounding grid and roof membrane to maintain roof adhesion to substrate.

B. Location: Provide EFVM detection system under all areas to receive SBS modified roof membrane.

2.11 WALKWAYS

A. Walkway Pads: Polymer-modified, reconstituted rubber pads with slip-resisting textured surface, manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 3/4 inch thick, minimum.

1. Pad Size: Manufacturer's standard size, minimum 30inches wide.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

    a. Test for moisture by pouring 1 pint of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.

6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
7. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane relative to adjoining deck.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. and allow primer to dry.

D. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

3.3 SUBSTRATE BOARD INSTALLATION

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

1. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
2. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

3.4 VAPOR-RETARDER INSTALLATION

A. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

3.5 INSULATION INSTALLATION

A. Comply with roofing system manufacturer's written instructions for installing roof insulation.

B. Install one lapped base-sheet course and mechanically fasten to substrate according to roofing system manufacturer's written instructions.

C. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane system with vertical surfaces or angle changes more than 45 degrees.

D. Install tapered insulation under area of roofing to conform to slopes indicated.

E. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

F. Install insulation under area of roofing to achieve required thickness. Install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

G. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

H. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

I. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
2. Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

J. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints a minimum of 6 inches in each direction from joints of insulation below. Loosely butt cover boards together. Tape joints if required by roofing system manufacturer.

1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
2. Apply hot roofing asphalt to underside, and immediately bond cover board to substrate.

3.6 EFVM LEAK DETECTION SYSTEM

A. Examine surfaces upon which grounding grid will be installed. Verify that membrane and penetrations are non-conductive materials or are electrically isolated by applications of additional layers of insulating materials.

B. Install EFVM leak detection system components per manufacturer’s recommendations and in accordance with approved shop drawings.

3.7 ROOFING MEMBRANE INSTALLATION, GENERAL

A. Install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing" and as follows:

1. Deck Type: I (insulated).
2. Adhering Method: M (mopped).
3. Base Sheet: One.
4. Surfacing Type: M (mineral-granule-surfaced cap sheet).

B. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.

C. Cooperate with testing agencies engaged or required to perform services for installing roofing system.

D. Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. At end of each day's work, provide tie-offs to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

E. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.

F. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.8 BASE-SHEET INSTALLATION

A. Install lapped base-sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:

1. Adhere to substrate in a solid mopping of hot roofing asphalt.

3.9 SBS-MODIFIED BITUMINOUS MEMBRANE INSTALLATION

A. Install modified bituminous roofing membrane cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:

1. Adhere to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F.
2. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.

B. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.

1. Repair tears and voids in laps and lapped seams not completely sealed.
2. Apply roofing granules to cover exuded bead at laps while bead is hot.

C. Install roofing membrane sheets so side and end laps shed water.

3.10 FLASHING AND STRIPPING INSTALLATION

A. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants in a solid mopping of hot roofing asphalt.
3. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F. Apply hot roofing asphalt to back of flashing sheet if recommended by roofing system manufacturer.

B. Extend base flashing up walls or parapets a minimum of 8 inches above roofing membrane and 4 inches onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

D. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.

E. Roof Drains: Set 30-by-30-inch- square metal flashing in bed of asphalt roofing cement on completed roofing membrane. Cover metal flashing with roofing membrane cap-sheet stripping and extend a minimum of 6 inches beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.

1. Install stripping according to roofing system manufacturer's written instructions.

3.11 WALKWAY INSTALLATION

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.

1. Set walkway pads in cold-applied adhesive.
2. Set walkway pads in additional pour coat of hot roofing asphalt after aggregate surfacing of modified bituminous roofing membrane.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections and to prepare test reports.

B. Quality control Program: Perform in-process quality control in accordance with the recommendations in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

C. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

1. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617.
2. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
3. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.

D. Electronic Field Vector Mapping (EFVM) Survey: After visual inspection and approval by roofing system manufacturer's technical personnel, perform an EFVM survey.

1. Provide testing to verify membrane is free of holes, open seams and capillary defects that will allow water to pass.
2. For EFVM testing provide following:
   a. Thoroughly wet waterproofing membrane in area of test. Wetting can be accomplished by hand or mechanical spray devises. Membrane shall be wet during testing procedures. Ponded water shall not be necessary.
   b. Allow testing technician to locate membrane breaches, if any. Technician shall mark on waterproofing membrane or surface exact location of defect and assign an identification number to each location.
   c. Visually inspect entire membrane area and repair breaches found. An EFVM retest shall be performed to confirm integrity of repair(s).
3. Technician shall prepare a report of each day's test results containing a written description and photograph of defect(s) located and a schematic CAD drawing indicating location of conductor wire and of defect(s) located in testing field to within 1" of accuracy. This report shall be made available in hard copy.
4. Submit written report of EFVM tests within 7 days following testing. Report results of tests, both successful and unsuccessful. In addition to results, report shall include date of test, project name, list of products being applied and tested, name of applicator, name of Contractor, and conditions causing failure of waterproofing in event of an unsuccessful test.

E. Roofing system will be considered defective if it does not pass tests and inspections.

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

F. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to perform final roofing inspection to confirm all repairs are performed in accordance with manufacturer's requirements and that system installation meets all warranty criteria

1. Notify Architect and Owner 48 hours in advance of date and time of inspection.

3.13 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.14 ROOFING INSTALLER'S WARRANTY

A. WHEREAS **<Insert name>** of **<Insert address>**, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: **Montgomery College**.
2. Address: **40 West Gude Drive, Suite 200, Rockville, MD 20850**.
3. Building Name/Type: **Bioscience Education Center**.
4. Address: **20200 Observation Drive, Germantown MD 20876**.
5. Area of Work: **<Insert information>**.
6. Acceptance Date: **<Insert date>**.
7. Warranty Period: **<Insert time>**.
8. Expiration Date: **<Insert date>**.

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed exceeding 90 mph;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this **<Insert day>** day of **<Insert month>**, **<Insert year>**.

1. Authorized Signature: **<Insert signature>**.
2. Name: **<Insert name>**.
3. Title: **<Insert title>**.

END OF SECTION 075216

SECTION 076100 - SHEET METAL ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Custom-fabricated, standing-seam sheet metal roofing.
   2. Seam mounted pad-type snow guards.

B. Related Requirements:

   1. Section 072100 "Thermal Insulation" for roof insulation and sheet vapor retarders separate from self-adhering underlayments.
   2. Section 061600 “Sheathing” for composite nail base insulated roof sheathing.
   3. Section 076200 "Sheet Metal Flashing and Trim" for gutters, downspouts and flashings that are not part of sheet metal roofing.
   4. Section 077100 "Roof Specialties" for manufactured copings that are not part of sheet metal roofing.
   5. Section 077200 "Roof Accessories" for manufactured roof accessories.
   6. Section 079200 "Joint Sealants" for field-applied sealants adjoining sheet metal roofing.

1.3 COORDINATION

A. Coordinate sheet metal roofing layout and seams with sizes and locations of roof curbs, equipment supports, equipment provided, and roof penetrations.

B. Coordinate sheet metal roofing installation with rain drainage work, flashing, trim, and construction of roofing substrate**,** parapets, walls, and other adjoining work to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

   1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review structural loading limitations of substrates during and after roofing installation.
   3. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affect sheet metal roofing.
   4. Review requirements for insurance and certificates if applicable.
   5. Review roof observation and repair procedures after sheet metal roofing installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Test Reports for Credit SS 7.2: For roofing materials, documentation indicating that roofing materials comply with Solar Reflectance Index requirement.

C. Shop Drawings: For sheet metal roofing.

1. Include plans, elevations, sections, and attachment details.
2. Show layouts and attachment details of snow guards.
3. Detail fabrication and installation layouts, expansion joint locations, fixed points, and keyed details. Distinguish between shop- and field-assembled work.
4. Include details for forming, including seams and dimensions.
5. Include details for joining and securing, including layout and spacing of fasteners, cleats, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints, including showing direction of expansion and contraction from fixed points.
8. Include details of roof penetrations.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.
12. Detail the following accessory items, at scale of not less than 1-1/2 inches per 12 inches:

a. Flashing and trim.
b. Gutters and downspouts as they relate to adjacent sheet metal roofing.
c. Roof curbs.
d. Attachment of snow guards.

D. Samples for Initial Selection: For each type of sheet metal with factory-applied finishes.

1. Include Samples of trim and accessories involving finish or color selection.
2. Snow guards: full-size sample.

E. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Roofing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, and other attachments.
2. Trim and Metal Closures: 12 inches long and in required profile. Include fasteners and other exposed accessories.
3. Other Accessories: 12-inch- long Samples for each type of other accessory.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Sheet metal roofing, seam locations, and attachments.
2. Roof hatches.
3. Equipment supports, pipe supports, and penetrations.
4. Lighting fixtures and cable runs.
5. Snow guards.
6. Items mounted on roof curbs.
7. Details for penetrations.

B. Qualification Data: For Installer.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

D. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing sheet metals and accessories to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Sheet Metal Roofing Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal roofing similar to that required for this Project and whose products have a record of successful in-service performance.

B. Mockups: Build mockups to verify selections made under Sample submittals to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup of typical roof area and eave as shown on Drawings, including, underlayment, attachments, and accessories.

   a. Size: Approximately 12 feet long by 6 feet.
   b. Include fascia and soffit.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal roofing materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal roofing materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal roofing from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal roofing installation.

1.10 WARRANTY

A. Special Warranty: Warranty form at end of this Section in which Installer agrees to repair or replace components of sheet metal roofing that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, rupturing, cracking, or puncturing.
b. Wrinkling or buckling.
c. Loose parts.
d. Failure to remain weathertight, including uncontrolled water leakage.
e. Deterioration of metals, metal finishes, and other materials beyond normal weathering, including nonuniformity of color or finish.
f. Galvanic action between sheet metal roofing and dissimilar materials.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal roofing that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Sheet metal roofing system including, but not limited to, metal roof panels, cleats, anchors and fasteners, sheet metal flashing integral with sheet metal roofing, fascia panels, trim, underlayment, and accessories, shall comply with requirements without failure due to defective manufacture, fabrication, or installation, or due to other defects in construction. Sheet metal roofing shall remain watertight.

B. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or indicated on Drawings.

C. Recycled Content of Aluminum-Sheet Roofing: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

D. Solar Reflectance Index: Not less than 29 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 ROOFING SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.

1. Thickness: 0.040 inch unless otherwise indicated.
2. Exposed Coil-Coated Finish:

    a. Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: As selected by Architect from manufacturer's full range.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Grace Construction Products, a unit of W. R. Grace & Co.-Conn.; Grace Ice and Water Shield HT.
    b. Henry Company; Blueskin PE200 HT.
    c. Kirsch Building Products, LLC; Sharkskin Ultra SA.
    d. Metal-Fab Manufacturing, LLC; MetShield.
    e. Owens Corning; WeatherLock Specialty Tile & Metal Underlayment.
    f. Polyguard Products, Inc.; Deck Guard HT.

2. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F or higher.
3. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.

B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete roofing system and as recommended by primary sheet metal manufacturer unless otherwise indicated.

B. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. General:

a. Exposed Fasteners: Heads matching color of sheet metal roofing using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of roofing.
b. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed; with hex-washer head.
c. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane, polysulfide, and silicone polymer sealants as recommended by sheet metal manufacturer for each application; of type, grade, class, and use classifications required to seal joints in sheet metal roofing and remain watertight.

E. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

2.5 ACCESSORIES

A. Sheet Metal Accessories: Provide components required for complete sheet metal roofing assembly including trim, copings, fasciae, corner units, clips, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items. Match material and finish of sheet metal roofing unless otherwise indicated.

1. Cleats: Intermittent and continuous attachment devices for mechanically seaming into joints and formed from the following materials and thicknesses unless otherwise indicated:

a. Aluminum Roofing: 0.0250-inch- thick stainless steel.

2. Expansion-Type Cleats: Cleats of a design that allows longitudinal movement of roof panels without stressing panel seams; of same material as other cleats.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible-closure strips; cut or premolded to match sheet metal roofing profile. Provide closure strips where necessary to ensure weathertight construction.
4. Flashing and Trim: Formed from same material and with same finish as sheet metal roofing, minimum 0.018 inch thick.

2.6 PAD-TYPE SNOW GUARDS

A. Seam-Mounted Metal Snow Guard Pads:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Alpine SnowGuards; a division of Vermont Slate & Copper Services, Inc.
   b. Berger Building Products.
   c. Geo-Tech Products.

2. Material, Finish, and Color: Cast aluminum; powder coat; color to match metal roof.

2.7 FABRICATION

A. General: Custom fabricate sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions (panel width and seam height), geometry, metal thickness, and other characteristics of installation. Fabricate sheet metal roofing and accessories in shop to greatest extent possible.

1. Standing-Seam Roofing: Form standing-seam panels with finished seam height of 2 inches.

B. Fabrication Tolerances: Fabricate sheet metal roofing that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

C. Form exposed sheet metal work to fit substrates with little oil canning; free of buckling and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.

1. Form sheet metal roofing pans to extend full length from eave to peak without transverse seams.
2. Fold and cleat eaves in shop.
3. Form and fabricate sheets, seams, strips, cleats, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements indicated on Drawings and as required for leakproof construction.

D. Expansion Provisions: Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

E. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to SMACNA standards.

F. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item required. Obtain field measurements for accurate fit before shop fabrication.

1. Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.

2. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices of sizes recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

G. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking, that tops of fasteners are flush with surface, and that installation is within flatness tolerances required for finished roofing installation.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored, and that provision has been made for drainage, flashings, and penetrations through sheet metal roofing.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating sheet metal roofing to verify actual locations of penetrations relative to seam locations of sheet metal roofing before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Lay out panel arrangement before installation of sheet metal roofing.

1. Space fasteners not more than 18 inches o.c.

3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6

inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.

1. Apply self-adhering sheet underlayment over entire roof.

B. Apply slip sheet, wrinkle free, over underlayment before installing sheet metal roofing and related flashing.

C. Install flashings to cover underlayment according to requirements in Section 076200 "Sheet Metal Flashing and Trim."

3.4 INSTALLATION, GENERAL

A. General: Install sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to installation characteristics required unless otherwise indicated on Drawings. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required for complete roofing system and as recommended by fabricator for sheet metal roofing.

1. Install sheet metal roofing true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement.
3. Field cutting of sheet metal roofing by torch is not permitted.
4. Provide metal closures at peaks, rake edges, and eaves.
5. Flash and seal sheet metal roofing with closure strips at eaves, rakes, and perimeter of all openings. Fasten with self-tapping screws.
6. Locate and space fastenings in uniform vertical and horizontal alignment. Predrill panels for fasteners.
7. Lap metal flashing over sheet metal roofing to direct moisture to run over and off roofing.
8. Do not use graphite pencils to mark metal surfaces.

B. Thermal Movement: Rigidly fasten metal roof panels to structure at only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction.

1. Avoid attaching accessories through roof panels in manner that inhibits thermal movement.

C. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

D. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by sheet metal manufacturer or SMACNA.

1. Coat concealed side of uncoated-aluminum sheet metal roofing with bituminous coating where roofing contacts wood, ferrous metal, or cementitious construction.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

3.5 CUSTOM-FABRICATED SHEET METAL ROOFING INSTALLATION

A. Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering metal temper and reflectivity. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant. Fold back sheet metal to form hem on concealed side of exposed edges unless otherwise indicated.

1. Install cleats to hold sheet metal panels in position. Attach each cleat with at least two fasteners to prevent rotation.
2. Space cleats not more than 12 inches o.c. Bend tabs over fastener head.
3. Provide expansion-type cleats for roof panels that exceed 30 feet in length.
4. Install metal roof pans parallel to eave line as shown on the drawings. Direction of pan slope is not the same as the direction of roof slope.

B. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

C. Standing-Seam Roofing: Attach standing-seam metal panels to substrate with double-fastened cleats spaced at 12 inches o.c. Install panels reaching from eave to ridge before moving to adjacent panels. Before panels are interlocked, apply continuous bead of sealant to top of flange of lower panel. Lock standing seams by folding over twice so cleat and panel edges are completely engaged.

1. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.

3.6 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for complete sheet metal roofing assembly including trim, copings, seam covers, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items.
2. Install accessories integral to sheet metal roofing that are specified in Section 076200 "Sheet Metal Flashing and Trim" to comply with that Section's requirements.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and install units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

1. Install flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.

2. Install continuous strip of self-adhering underlayment at edge of continuous flashing overlapping self-adhering underlayment, where "continuous seal strip" is indicated in SMACNA's "Architectural Sheet Metal Manual" and on Drawings.
3. Install exposed flashing and trim without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates, and to result in waterproof and weather-resistant performance.
4. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

    a. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, and filled with butyl sealant concealed within joints.
    b. Use lapped expansion joints only where indicated on Drawings.

C. Pipe Flashing: Form flashing around pipe penetration and sheet metal roofing. Fasten and seal to sheet metal roofing as recommended by SMACNA.

D. Roof Curbs: Install flashing around bases where curbs meet sheet metal roofing.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal roofing within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.8 SNOW GUARDS

A. Install snow guards according to manufacturer's written instructions.

B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing, or fastening methods that void metal roofing finish warranty.
2. Seam-Mounted Metal Snow Guard Pads: Cast aluminum clamps attached to vertical ribs of standing-seam metal roof panels.

3.9 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal roofing is installed unless otherwise indicated in manufacturer's written installation instructions. On completion of

sheet metal roofing installation, clean finished surfaces as recommended by sheet metal roofing manufacturer. Maintain sheet metal roofing in clean condition during construction.

E. Replace sheet metal roofing components that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.10 ROOFING INSTALLER'S WARRANTY

A. WHEREAS **<Insert name>** of **<Insert address>**, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: **<Insert name>**.
2. Owner's Address: **<Insert address>**.
3. Building Name/Type: **<Insert information>**.
4. Building's Address: **<Insert address>**.
5. Area of Work: **<Insert information>**.
6. Acceptance Date: **<Insert date>**.
7. Warranty Period: **<Insert time>**.
8. Expiration Date: **<Insert date>**.

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. Lightning;
    b. Peak gust wind speed exceeding **<Insert mph>**;
    c. Fire;
    d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. Vapor condensation on bottom of roofing; and
    g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with

penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this **<Insert day>** day of **<Insert month>**, **<Insert year>**.

1. Authorized Signature: **<Insert signature>**.
2. Name: **<Insert name>**.
3. Title: **<Insert title>**.

END OF SECTION 076100

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Formed Products:

a. Formed roof drainage sheet metal fabrications.
b. Formed low-slope roof sheet metal fabrications.
c. Formed equipment support flashing.

B. Related Sections:

1. Division 06 Section “Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Division 07 Section "SBS Modified Bituminous membrane Roofing" for installing sheet metal flashing and trim integral with membrane roofing.
3. Division 07 Section "Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
4. Division 07 Section "Sheet Metal Roofing" for custom-formed sheet metal flashing and trim integral with sheet metal roofing.
5. Division 07 Section "Roof Specialties" for manufactured roof specialties not part of sheet metal flashing and trim.
6. Division 07 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
7. Division 07 Section "Expansion Control" for manufactured sheet metal expansion-joint covers.

1.3 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:

1. Identification of material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
4. Details of termination points and assemblies, including fixed points.
5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
7. Details of special conditions.
8. Details of connections to adjoining work.
9. Detail formed flashing and trim at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
3. Accessories and Miscellaneous Materials: Full-size Sample.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified fabricator.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

PART 2 - PRODUCTS

2.1 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.

1. Finish: 4 (polished directional satin).
2. Surface: Smooth, flat.

2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

C. Solder:

1. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

E. Preformed Silicone Tape: Use to seal edges of stainless steel flashings at curtain wall perimeters.

1. 3" wide preformed, ultra-low modulus silicone elastomer extrusion bonded to substrates with silicon building sealant.

a. Dow Corning 123 Silicone Tape.

F. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

G. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
2. Obtain field measurements for accurate fit before shop fabrication.
3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.

E. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

G. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

H. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

I. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

J. Do not use graphite pencils to mark metal surfaces.

2.4 ROOF DRAINAGE SHEET METAL FABRICATIONS

A. Built-in Gutters: Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in minimum 96-inch- long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.

1. Fabricate gutters with built-in expansion joints.
2. Fabricate from the following materials:

    a. Stainless Steel: 0.016 inch thick.

B. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Fabricate from the following materials:

    a. Stainless Steel: 0.016 inch thick.

2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof-Penetration Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.019 inch thick.

B. Roof-Drain Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.016 inch thick.

2.6 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.019 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
5. Install sealant tape where indicated.
6. Torch cutting of sheet metal flashing and trim is not permitted.
7. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.

1. Coat back side of stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

D. Fastener Sizes: Use fasteners of sizes that will penetrate metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal joints as shown and as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.

1. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
2. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

3.3 ROOF DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Built-in Gutters: Joined sections to be riveted and soldered. Provide for thermal expansion. Slope to downspouts. Provide end closures and seal watertight with sealant.

1. Install self adhered waterproofing layer in built-in gutter trough and extend onto roof insulation a minimum 36”. Lap ends a minimum of 6 inches. Install slip sheet over waterproofing.
2. Anchor edges of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
3. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.

C. Downspouts: Join sections with 1-1/2-inch telescoping joints.

1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c. in between.
2. Provide elbows at base of downspout to direct water away from building.
3. Connect downspouts to underground drainage system indicated.

3.4 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

B. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.5 MISCELLANEOUS FLASHING INSTALLATION

A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.6 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.7 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.

E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Copings.
2. Reglets and counterflashings.

B. Related Sections:

1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Division 07 Section "Sheet Metal Roofing" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.
3. Division 07 Section "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
4. Division 07 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
5. Division 07 Section "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.
6. Division 07 Section "Expansion Control" for manufactured sheet metal expansion-joint covers.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

PART 2 - PRODUCTS

2.1 EXPOSED METALS

A. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

1. Surface: Smooth, flat finish.
2. Exposed Coil-Coated Finishes: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:

1. Exposed High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Three-Coat Fluoropolymer: AAMA 2605. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

2.2 CONCEALED METALS

A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

D. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.
2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Carlisle Coatings & Waterproofing; CCW WIP 300HT.
    b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
    c. Metal-Fab Manufacturing, LLC; MetShield.
    d. Owens Corning; WeatherLock Metal High Temperature Underlayment.

C. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.

D. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

2.5 COPINGS

A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet, concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Hickman Company, W. P.
    b. Johns Manville.
    c. MM Systems Corporation.
    d. Petersen Aluminum Corporation.

2. Coping-Cap Material: Formed aluminum, 0.063 inch thick.

    a. Finish: Three-coat fluoropolymer.
    b. Color: Match Architect's sample.

3. Corners: Factory mitered and continuously welded.
4. Coping-Cap Attachment Method: Face legs hooked to continuous cleats with continuous spring lock.
5. Face Leg Cleats and spring locks: Concealed, continuous stainless steel.

2.6 REGLETS AND COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Fry Reglet Corporation.
2. Hickman Company, W. P.
3. Metal-Fab Manufacturing, LLC.

4. MM Systems Corporation.

B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:

1. Stainless Steel: 0.025 inch thick.
2. Corners: Factory mitered and soldered.
3. Multiuse Type, Embedded: For multiuse embedment in cast-in-place concrete and masonry mortar joints.

C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:

1. Stainless Steel: 0.019 inch thick.

D. Accessories:

E. Stainless-Steel Finish: No. 4 (bright, polished directional satin).

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

B. Self-Adhering Sheet Underlayment: Install wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water. Overlap edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

C. Polyethylene Sheet: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches.

D. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

3.3 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of self-adhering, high-temperature sheet underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise shown on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.4 COPING INSTALLATION

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings to meet performance requirements.

1. Interlock face leg drip edges into continuous cleats anchored to substrate at manufacturer's required spacing that meets performance requirements.
2. At curtainwall, form front leg of coping to fit into glazing channel and secure as required.
3. Abut ends of coping sections over prefinished splice plates with neoprene or butyl sealant strips allowing space for expansion.

3.5 REGLET AND COUNTERFLASHING INSTALLATION

A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Embedded Reglets: See Division 03 Section "Cast-in-Place Concrete" and Division 04 Section "Unit Masonry" for installation of reglets.

3.6 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077110 - VEGETATED ROOF MODULES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes pre-vegetated modular green roof units, slip sheet/root barrier, pre-cast roof pavers, and accessories.

B. Related Sections:

1. Division 07 Section 075216 “Styren-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing” for roofing under vegetated roof modules.

1.3 SCOPE

A. Provide equipment, materials, tools, and labor to install vegetated roofing modules. Modules to include growth media and plants. This work shall also include edge treatments, custom shaping of modules, and installing paver stones or ballast, and slip sheet/root barrier.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to Vegetated Roof Module installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions.
c. Review substrate preparation procedures.

1.5 SUBMITTALS

A. Product data for vegetated roofing systems.

B. Planting mix design indicating species.

C. Shop Drawings: Indicating layout of modules, pavers, and square footage.

D. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner’s name and registered with manufacturer.

E. Maintenance instructions for inclusion into owner’s manuals.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Submit manufacturer's recommendations for vegetated roof module maintenance, including weeding, watering, and application of herbicides, pesticides, and fertilizers.

B. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement covering all recommended maintenance procedures, including weeding, watering, and application of herbicides, pesticides, and fertilizers, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.7 QUALITY ASSURANCE

A. Source limitations: Obtain all components of vegetated roof module system from single source.

B. Installer qualifications: A qualified firm that is certified by vegetated roof module system manufacturer to install manufacturer's product.

C. Prior to installing vegetated roof modules, the following procedures are to be conducted:

1. Verify that the roof has been tested for water tightness.
2. Verify that slip-sheet/root barrier is properly installed, seams overlapped and bonded, in accordance with manufacturer's specifications.

D. Install vegetated roof modules tight against each other, in straight rows, corners aligned, properly oriented, and tight against the edging.

1.8 DELIVERY, STORAGE, HANDLING, PROTECTION

A. Vegetated Roof modules are to be delivered in good condition free from shipping damage.

B. Vegetated Roof modules are to be kept out of the sun if plastic wrapped to prevent overheating.

C. Vegetated Roof modules are to be installed on the roof top within 4 hours of delivery.

D. Never exceed the load capacity of the roof deck when placing Vegetated Roof modules on the roof.

E. During installation, protect the roof deck and membranes with appropriate material such as plywood sheeting. Never scrape or puncture slip sheet or membranes. Keep roof surfaces free of soil, grit, or debris at all times with broom. Never set Vegetated Roof modules on top of soil, dirt or grit.

F. Transport conveyors to be run parallel to the line of installation.

G. Transport carts to have pneumatic tires, to be wheeled about only upon protective plywood sheeting, and to be loaded so as not to exceed weight capacity of roof deck.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Carlisle Coatings and Waterproofing Incorporated, CCW Greengrid.
2. Firestone Building Products; Skyscape Vegetative Tray.
3. LiveRoof, LLC; Subsidiary of Hortech, Inc.

2.2 VEGETATED ROOFING MODULES

A. Provide pre-vegetated, nursery grown roof modules.

B. Material: Recycled polypropylene, colored black or gray.

C. Size: Manufacturer's standard module size, maximum four square feet in area.

D. Soil depth: Minimum 4 inches.

E. Module clearance above roof deck: ½ inch.

F. Growing medium: manufacturer's proprietary engineered blend of inorganic and organic components based upon German FLL granulometric guidelines modified so as to contain ecologically sustainable levels of organic content.

G. Plants: Manufacturer recommended plant mixes consisting of highly drought resistant ground covers.
1. Planting density – Plants should be supplied at minimum 8" on center.
2. Plants to be grown to maturity, minimum 1" above module surface, at time of installation.

2.3 PRE-CAST ROOF PAVERS

A. Provide paver system integrated with vegetated roofing modules of appropriate depth to form edge. Pavers to follow roof contours to maintain height relative to the vegetated roofing modules.

B. Provide precast concrete pavers with the following characteristics:

1. Compressive Strength >4000 psi Avg per ASTM C-140
2. Flexural Strength >600 psi per ASTM C-293
3. Water Absorption <5 % per ASTM C-936
4. Coefficient of Friction >0.6 % per ASTM C-1028
5. Freeze Thaw <1 % per ASTM C-67
6. Solar Reflectance Index (SRI) ≥ 78.

C. Provide with adjustable pedestals or leveling shims.

D. Paver units to allow free drainage of water under unit.

2.4 ACCESSORIES

A. Slip sheet/root barrier: Waterproof membrane sheet compatible with and approved by SBS modified built up roofing system manufacturer with glued or welded seams to install over built up roof membrane and provide protection against root penetration.

1. Thickness: Minimum 60 mils.

B. Drainage Board: As required for compatibility of EFVM leak detection system, provide fiber backed drain board compatible with the roofing system and plant materials.

C. Edging: L-shaped extruded aluminum edging compatible with vegetated roof modules with perforations for drainage.

1. Provide edging between modules and stone ballast or pavers.

D. Roof Drain Covers:

PART 3 - EXECUTION

3.1 PREPARATION

A. Do not install vegetated roof modules, roof pavers, or slip sheet/root barrier until modified bitumen roof system is complete, inspected, and EFVM tested in accordance with the requirements of specification section 075216 - STYREN-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING.

B. Slip sheet/root barrier as approved by SBS modified roofing manufacturer, of 60 mil. thickness with overlapped and effectively bonded seams to ward against root penetration and to keep waterproofing layer safe and clean from soil during installation.

1. Minimum 60 mil EPDM, with seams overlapped a minimum of 3 inches and glued with roll out adhesive of the type that is impervious to and not affected by moisture, and recommended by the manufacturer. Experienced Contractor to install slip sheet/root barrier in accordance with manufacturer's recommendations.

C. All surfaces to be smooth, free of debris, soil, and grit prior to placing modules. All materials to be tested water tight and free draining prior to module placement. All surfaces to be maintained clean and free of debris, soil, and grit during installation process via use of broom. Never walk upon such materials as they may damage membranes.

3.2 ENVIRONMENTAL CONDITIONS

A. Module Installation to be conducted when plants are:

1. Properly adapted and acclimatized to local weather conditions.
2. When weather is above 35° F, there is no ice on the roof and roof module soil is unfrozen.

3.3 INSTALLING ROOF PAVERS

A. Preparation:
1. Sweep slip sheet protective sheeting clean of gravel, grit, soil or any other debris.

2. Do not apply pavers to unclean surface.

B. Installation:
1. Determine efficient starting point based upon design and logistics.
2. Apply chalk line if appropriate for the design.
3. Install pavers tightly against vegetated modules or edge restraint.
4. Check each paver at time of paver placement, to confirm that it fits solidly on the roof deck. Apply shim(s) or adjust pedestals as needed to remove any rocking movement.
5. Do not place the next paver until certain there is no rocking motion/play in the previously placed module.
6. Custom cut paver units as needed to conform to the paver layout. Ease corners and edges to prevent chipping.

3.4 LAYING (PLACING) MODULES

A. Vegetated roof module installation to follow behind installation of slip sheet/root barrier, irrigation system, pavers, ballast, and edging.

B. Vegetated roof installation to be conducted in strict accordance with Vegetated roof installation guidelines. Rows to be straight, modules to be tight against each other with edges overlapping and arranged in proper directional orientation.

C. Vegetated roof modules to be placed directly on top of appropriate slip sheet/root barrier.

D. After installing modules, they should be immediately watered so as to thoroughly moisten the media from top to bottom. Water shall be of suitable quality for plant growth and irrigation system or hoses and sprinklers may be used for such purpose.

3.5 ACCEPTANCE

A. Conduct post installation inspection to determine acceptance of modules. Inspection to be made by General Contractor's Representative or by Owner's Representative upon General Contractor's request; five working days notice required.

B. Upon acceptance, Owner assumes responsibility for module/plant maintenance.

3.6 CLEAN UP

A. Throughout installation, keep all work surfaces clean and free of grit, dirt, or debris. Use broom not blower, do not sweep soil under modules or slip sheet. Following installation, remove all excess materials and tools from job site. Ensure that any damage that occurs as a result of installation is appropriately and immediately repaired.

END OF SECTION 077110

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.
4. Preformed flashing sleeves.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for metal ships' ladders for access to roof hatches.
2. Section 076100 "Sheet Metal Roofing" for shop- and field-formed roof curbs and snow guards for sheet metal roofing.
3. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
4. Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, gutters and downspouts, and counterflashing.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.8 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

A. Aluminum Sheet: ASTM B 209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: As manufactured.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.

3. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
4. Exposed Coil-Coated Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Two-Coat Fluoropolymer Finish: AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

5. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Aluminum Extrusions and Tubes: ASTM B 221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.

C. Copper Sheet: ASTM B 370, manufacturer's standard temper.

D. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.

E. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.

F. Steel Tube: ASTM A 500, round tube.

G. Galvanized-Steel Tube: ASTM A 500, round tube, hot-dip galvanized according to ASTM A 123/A 123M.

H. Steel Pipe: ASTM A 53/A 53M, galvanized.

2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Underlayment:

1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.
3. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.

F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened.

Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

H. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

I. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

J. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. AES Industries, Inc.
   b. Curbs Plus, Inc.
   c. Custom Solution Roof and Metal Products.
   d. Greenheck Fan Corporation.
   e. LM Curbs.
   f. Metallic Products Corp.
   g. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
   h. Roof Products, Inc.
   i. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Stainless-steel sheet, 0.078 inch thick.

1. Finish: Manufacturer's standard.

D. Construction:

1. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
2. Liner: Same material as curb, of manufacturer's standard thickness and finish.

3. Factory-installed wood nailer at top of curb, continuous around curb perimeter.
4. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
5. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
6. Top Surface: Level around perimeter with roof slope accommodated by sloping the deck-mounting flange.
7. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.

2.4 EQUIPMENT SUPPORTS

A. Equipment Supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. AES Industries, Inc.
b. Curbs Plus, Inc.
c. Custom Solution Roof and Metal Products.
d. Greenheck Fan Corporation.
e. LM Curbs.
f. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
g. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Stainless-steel sheet, 0.078 inch thick.

1. Finish: Manufacturer's standard.

D. Construction:

1. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
3. Factory-installed continuous wood nailers 3-1/2 inches wide at tops of equipment supports.
4. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
5. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
6. Fabricate equipment supports to minimum height of 12 inches unless otherwise indicated.
7. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.
8. Security Grille: Provide where indicated.

2.5 PREFORMED FLASHING SLEEVES

A. Pipe Penetration Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange with removable metal hood and slotted metal collar.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Custom Solution Roof and Metal Products.
b. Thaler Metal USA Inc.

2. Metal: Stainless-steel sheet, 0.078 inch thick.
3. Height: As required to accommodate insulation thickness plus minimum 10 inch extension above roof surface.
4. Diameter: As required for penetrating item plus minimum 1 inch interstitial space.
5. Finish: Manufacturer's standard.

B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Custom Solution Roof and Metal Products.
b. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
c. Thaler Metal USA Inc.

2. Metal: Stainless-steel sheet, 0.078 inch thick..
3. Height: As required to accommodate insulation thickness plus minimum 10 inch extension above roof surface.
4. Diameter: As required for penetrating item plus minimum 1 inch interstitial space.
5. Finish: Manufacturer's standard.

2.6 ROOF HATCH

A. Roof Hatches: Metal roof-hatch unit with lid and insulated single-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. AES Industries, Inc.
b. Babcock-Davis.
c. Bilco Company (The).
d. Nystrom.
e. O'Keeffe's Inc.

B. Type and Size: Single-leaf lid, 30 by 72 inches.

C. Loads: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.

D. Hatch Material: Stainless-steel sheet, 0.078 inch thick.

1. Finish: Manufacturer's standard.

E. Construction:

1. Insulation: Glass-fiber board.
2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
3. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
4. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.

F. Hardware: Stainless-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.

G. Hatch Rail System:

1. Hatch rail system shall be field assembled and installed per the manufacturer's instructions.
2. Performance characteristics:

a. Railing System shall consist of a top rail, mid rail, and self closing gate.
b. Railing system shall extend to a height of at least 42" from the finished roof deck.
c. Hatch rail system shall attach to the capflashing of the roof hatch and shall not penetrate any roofing material.
d. Hatch rail system shall satisfy the requirements of OSHA 29 CFR 1910.23 and shall meet OSHA strength requirements with a factor of safety of two.

3. Posts and Rails: Shall be round galvanized steel or aluminum pipe prepped for field painting.
4. Hardware: Mounting brackets shall be hot dip galvanized steel, stainless steel, or aluminum per manufacturer's standard. Fasteners shall be Type 316 stainless steel.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum OR stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof Curb Installation: Install each roof curb so top surface is level.

D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.

E. Preformed Flashing-Sleeve Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions.

F. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Clean exposed surfaces according to manufacturer's written instructions.

C. Clean off excess sealants.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078100 - APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes sprayed fire-resistive materials (SFRM).

B. Related Requirements:

1. Section 078123 "Intumescent Mastic Fireproofing" for mastic and intumescent fire-resistive coatings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.2: For paints and coatings, documentation including printed statement of VOC content.

C. Shop Drawings: Framing plans, schedules, or both, indicating the following:

1. Extent of fireproofing for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3. Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of fireproofing after application.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Product Certificates: For each type of fireproofing.

C. Evaluation Reports: For fireproofing, from ICC-ES.

D. Preconstruction Test Reports: For fireproofing.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.

1. Build mockup of each type of fireproofing and different substrate as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups of fireproofing.

1. Provide test specimens and assemblies representative of proposed materials and construction.

B. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.

1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
2. Density: Test for density according to ASTM E 605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 or UL 263 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction and the following VOC limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.

E. Asbestos: Provide products containing no detectable asbestos.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

A. SFRM: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and conveyed in a dry state and mixed with atomized water at place of application.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Carboline Company, subsidiary of RPM International, Fireproofing Products Div.; AD Southwest Fireproofing Type 5GP.
   b. Grace, W. R. & Co. - Conn.; Grace Construction Products; Monokote MK-6 Series.
   c. Isolatek International; Cafco 300.

2. Bond Strength: Minimum 150-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E 736.
3. Density: Not less than 15 lb/cu. ft. and as specified in the approved fire-resistance design, according to ASTM E 605.

4. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E 605, whichever is thicker, but not less than 0.375 inch.
5. Combustion Characteristics: ASTM E 136.
6. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 10 or less.
    b. Smoke-Developed Index: 10 or less.

7. Compressive Strength: Minimum 10 lbf/sq. in. according to ASTM E 761.
8. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
9. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
11. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. in 24 hours according to ASTM E 859.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:

1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E 736.

C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:

1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
2. Objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.

3. Substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.

B. Conduct tests according to fireproofing manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.

B. Clean substrates of substances that could impair bond of fireproofing.

C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.

1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.

D. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

E. Spray apply fireproofing to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.

F. Extend fireproofing in full thickness over entire area of each substrate to be protected.

G. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.

H. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.

I. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.

J. Cure fireproofing according to fireproofing manufacturer's written recommendations.

K. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.

L. Finishes: Where indicated, apply fireproofing to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC, 1704.10.

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fireproofing will be considered defective if it does not pass tests and inspections.

1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.5 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.

C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

D. Repair fireproofing damaged by other work before concealing it with other construction.

E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078100

SECTION 078123 - INTUMESCENT MASTIC FIREPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes mastic and intumescent fire-resistive coatings (MIFRC).

B. Related Requirements:

1. Division 07 Section "Applied Fireproofing" for sprayed fire-resistive materials (SFRM).

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review products, design ratings, restrained and unrestrained conditions, thicknesses, and other performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.2: For paints and coatings, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit EQ 4: For paints and coatings, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Structural framing plans indicating the following:

1. Extent of fireproofing for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3. Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of fireproofing after application.

D. Samples: For each exposed product and for each color and texture specified, 4 inches square in size.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of fireproofing.

C. Evaluation Reports: For fireproofing, from ICC-ES.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of each type of fireproofing and different substrate and each required finish as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 50 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction and the following VOC limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
5. Fireproofing Exterior Coatings: 350 g/L.

E. Low-Emitting Materials: Fireproofing used within the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Asbestos: Provide products containing no detectable asbestos.

2.2 MASTIC AND INTUMESCENT FIRE-RESISTIVE COATINGS

A. MIFRC: Manufacturer's standard, factory-mixed formulation or factory-mixed, multicomponent system consisting of intumescent base coat and topcoat, and complying with indicated fire-resistance design.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Albi Manufacturing, Division of StanChem Inc.; Albi Clad TF.
   b. Carboline Company, subsidiary of RPM International, Fireproofing Products Div.; AD Firefilm III.
   c. Isolatek International; Cafco SprayFilm-WB 3.

2. Application: Designated for "interior general purpose" use by a qualified testing agency acceptable to authorities having jurisdiction.
3. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
4. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 or less.

5. Hardness: Not less than 65, Type D durometer, according to ASTM D 2240.
6. Finish: .

   a. Color and Gloss: Match Architect's sample.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Topcoat: Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:

1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
2. Objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.

B. Conduct tests according to fireproofing manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.

B. Clean substrates of substances that could impair bond of fireproofing.

C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.

1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.

D. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

E. Spray apply fireproofing to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.

F. Extend fireproofing in full thickness over entire area of each substrate to be protected.

G. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.

H. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.

I. Cure fireproofing according to fireproofing manufacturer's written recommendations.

J. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.

K. Finishes: Where indicated, apply fireproofing to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.
2. Skip-Troweled Finish: Even leveled surface produced by troweling spray-applied finish to smooth out the texture and neaten edges.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC, 1704.11.

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed

applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fireproofing will be considered defective if it does not pass tests and inspections.

1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

3.5 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.

C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

D. Repair fireproofing damaged by other work before concealing it with other construction.

E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078123

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Sections:

1. Section 078446 "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.
2. Section 233300 “Air Duct Accessories” for fire and smoke dampers at mechanical duct penetrations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittal:

1. Product Data for Credit IEQ 4.1: For penetration firestopping sealants and sealant primers, documentation including printed statement of VOC content.

C. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
    b. Classification markings on penetration firestopping correspond to designations listed by the following:

        1) UL in its "Fire Resistance Directory."

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Grace Construction Products.
2. Hilti, Inc.
3. 3M Fire Protection Products.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Fire-resistance-rated walls include fire-barrier walls and smoke-barrier walls.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. Horizontal assemblies include floors.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated. At joints in non-rated horizontal assemblies, provide barriers that resist the passage of smoke and flame.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

    a. Slag-wool-fiber or rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Firestopping with No Penetrating Items:

1. UL-Classified Systems:
   a. Horizontal Assemblies: F-A-0001-0999
   b. Concrete or masonry Walls: W-J-0001-0999
   c. Frame Walls: W-L-0001-0999

C. Firestopping for Metallic Pipes, Conduit, or Tubing:
1. UL-Classified Systems:
   a. Horizontal Assemblies: F-A-1001-1999
   b. Concrete or masonry Walls: W-J-1001-1999
   c. Frame Walls: W-L-1001-1999

D. Firestopping for Nonmetallic Pipe, Conduit, or Tubing:
1. UL-Classified Systems:
   a. Horizontal Assemblies: F-A-2001-2999
   b. Concrete or masonry Walls: W-J-2001-2999
   c. Frame Walls: W-L-2001-2999

E. Firestopping for Electrical Cables:
1. UL-Classified Systems:
   a. Horizontal Assemblies: F-A-3001-3999
   b. Concrete or masonry Walls: W-J-3001-3999
   c. Frame Walls: W-L-3001-3999

F. Firestopping for Miscellaneous Electrical Penetrants:
1. UL-Classified Systems:
   a. Horizontal Assemblies: F-A-6001-6999
   b. Concrete or masonry Walls: W-J-6001-6999
   c. Frame Walls: W-L-6001-6999

G. Firestopping for Miscellaneous Mechanical Penetrants:
1. UL-Classified Systems:
   a. Horizontal Assemblies: F-A-7001-7999
   b. Concrete or masonry Walls: W-J-7001-7999
   c. Frame Walls: W-L-7001-7999

END OF SECTION 078413

SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints at exterior curtain-wall/floor intersections.
3. Joints in smoke barriers.

B. Related Sections:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.
2. Section 079500 "Expansion Control" for fire-resistive architectural joint systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For fire-resistive joint system sealants, documentation including printed statement of VOC content.

C. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.

1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:

1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:

    a. Fire-resistive joint system products bear classification marking of qualified testing agency.
    b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:

        1) UL in its "Fire Resistance Directory."

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Grace Construction Products.
    b. Hilti, Inc.
    c. 3M Fire Protection Products.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg or ASTM E 2307.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly. Where not rated, provide joint systems to resist the passage of smoke and flame.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Grace Construction Products.
    b. Hilti, Inc.
    c. 3M Fire Protection Products.

D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Grace Construction Products.
    b. Hilti, Inc.
    c. 3M Fire Protection Products.

E. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. VOC Content: Fire-resistive joint system sealants shallcomply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

G. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
2. Date of installation.
3. Manufacturer's name.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.

C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.7 FIRE-RESISTIVE JOINT SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.

B. Floor-to-Floor, Fire-Resistive Joint Systems:

1. UL-Classified Systems: FF-D- 1000-1999.

C. Head-of-Wall, Fire-Resistive Joint Systems:

1. UL-Classified Systems: HW- S- 0000-0999.

D. Perimeter Joint Systems:

1. Non-rated system to resist the passage of smoke and flame

END OF SECTION 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies" for masonry control and expansion joint fillers and gaskets.
2. Division 7 Section "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.
3. Division 8 Section "Glazing" for glazing sealants.
4. Division 9 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.
5. Division 9 Section "Ceramic Tile" for sealing tile joints.
6. Division 9 Section "Acoustical Panel Ceilings" for sealing edge moldings at perimeters of acoustical ceilings.

1.3 PERFORMANCE REQUIREMENTS

A. Provide joint sealants for exterior and interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

E. Qualification Data: For Installer and testing agency.

F. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

G. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period preceding the commencement of the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:

a. Each type of elastomeric sealant and joint substrate indicated.
b. Each type of nonelastomeric sealant and joint substrate indicated.

3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

E. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:

1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

D. Single-Component Neutral-Curing Silicone Sealant ES-1:

1. Available Products:

a. Dow Corning Corporation; 790.
b. Pecora Corporation; 890.
c. Sonneborn, Division of ChemRex Inc.; Omniseal.
d. Tremco; Spectrem 3.

2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 100/50.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

a. Use O Joint Substrates: aluminum coated with a high-performance coating, galvanized steel, brick, granite, and cast stone.

6. Stain-Test-Response Characteristics: Nonstaining to porous substrates per ASTM C 1248.

E. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant ES-2:

1. Available Products:

a. Dow Corning Corporation; 786.
b. Pecora Corporation; 898.
c. Tremco; Tremsil 600.

2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 25.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

    a. Use O Joint Substrates: ceramic tile.

F. Single-Component Pourable Urethane Sealant ES-3:

1. Available Products:

    a. Pecora Corporation; Urexpan NR-201.
    b. Polymeric Systems, Inc.; Flexiprene 952.
    c. Tremco; Tremflex S/L.

2. Type and Grade: S (single component) and P (pourable).
3. Class: 25.
4. Use Related to Exposure: T (traffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

    a. Use O Joint Substrates: brick and concrete.

2.4 LATEX JOINT SEALANTS

A. Latex Sealant LS-1: Comply with ASTM C 834, Type P, Grade NF.

B. Available Products:

1. Pecora Corporation; AC-20+.
2. Sonneborn, Division of ChemRex Inc.; Sonolac.
3. Tremco; Tremflex 834.

2.5 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints AS-1: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following:

1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
2. Available Products:

    a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
    b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

2.6 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Cast stone.

d. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

PART 4 - JOINT SEALER SCHEDULE

Designation	Joint Sealer	Description of joint construction and location where joint sealer is typically applied (see note below)
ES 1	Single-Component Neutral-Curing Silicone Sealant	One-Part Nonacid-Curing exterior and interior joints in vertical surfaces of concrete and masonry; between metal and concrete, mortar, or stone; interior and exterior perimeter joints of metal frames in exterior walls; and exterior overhead joints.
ES 2	Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant	Interior joints in vertical surfaces of ceramic tile in toilet rooms.
ES 3	Single-Component Pourable Urethane Sealant	Exterior and interior joints in horizontal surfaces of concrete; between metal and concrete, mortar, and masonry.
LS-1	Latex Sealant	Interior joints in field-painted vertical and overhead surfaces at perimeter of hollow metal door frames; in gypsum drywall, and concrete or concrete masonry; and all other interior joints not indicated otherwise.
AS-1	Acoustical Sealant for Exposed and Concealed Joints	As indicated in Division 9 Section "Gypsum Board Assemblies"

Note: Install joint sealer indicated in joints fitting descriptions and locations listed as well as in locations identified on Drawings.

END OF SECTION 079200

SECTION 079500 - EXPANSION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior expansion control systems.
2. Exterior wall expansion control systems.

B. Related Requirements:

1. Section 078446 "Fire-Resistive Joint Systems" for liquid-applied joint sealants in fire-resistive building joints.
2. Section 079200 "Joint Sealants" for liquid-applied joint sealants.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, blockout requirement, attachments to other work, and line diagrams showing entire route of each expansion control system. Where expansion control systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

B. Samples: For each exposed expansion control system and for each color and texture specified, full width by 6 inches long in size.

C. Samples for Initial Selection: For each type of expansion control system indicated.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

D. Samples for Verification: For each type of expansion control system indicated, full width by 6 inches long in size.

E. Product Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion control system.
2. Expansion control system location cross-referenced to Drawings.
3. Nominal joint width.
4. Movement capability.
5. Classification as thermal or seismic.
6. Materials, colors, and finishes.

7. Product options.
8. Fire-resistance ratings.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. General: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.

1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.
2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.

B. Coordination: Coordinate installation of exterior wall and soffit expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified elsewhere.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Where indicated, provide expansion control systems with fire barriers identical to those of systems tested for fire resistance per UL 2079 or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction.

2.3 INTERIOR EXPANSION CONTROL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Balco, Inc.
2. Construction Specialties, Inc.
3. MM Systems Corporation.

B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.

C. Floor-to-Floor EJ-11 and EJ-12:

1. Design Criteria:

a. Nominal Joint Width: As indicated on Drawings.
b. Movement Capability: -25 percent/+75 percent.
c. Type of Movement: Thermal.
d. Load Capacity:

1) Uniform Load: 150 lb/sq. ft..
2) Concentrated Load: 2000 lb.
3) Maximum Deflection: 0.5 inch.

e. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction. Where non-rated, provide barrier to resist the passage of smoke and flame.

2. Type: Dual Elastomeric.

a. Cover Plate Infill:

1) EJ-11 to receive 3/8" terrazzo infill.
2) EJ-12 to receive carpet infill.

D. Wall-to-Wall EJ-8:

1. Design Criteria:

a. Nominal Joint Width: As indicated on Drawings.
b. Movement Capability: -25 percent/+75 percent.
c. Type of Movement: Thermal.

2. Type: Flat seal.

a. Metal: Stainless steel.

1) Finish: No. 4.

b. Seal Material: Santoprene.

1) Color: White.

E. Wall Corner EJ-9:

1. Design Criteria:

a. Nominal Joint Width: As indicated on Drawings.
b. Movement Capability: -25 percent/+75 percent.
c. Type of Movement: Thermal.

2. Type: Flat seal.

a. Metal: Stainless steel.

1) Finish: No. 4.

b. Seal Material: Santoprene.

1) Color: White.

F. Ceiling-to-Ceiling EJ-13:

1. Design Criteria:

a. Nominal Joint Width: As indicated on Drawings.
b. Type of Movement: Thermal.

2. Type: Flat seal.

a. Metal: Stainless steel.

1) Finish: No. 4.

b. Seal Material: Santoprene.

1) Color: White.

2.4 EXTERIOR WALL EXPANSION CONTROL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Balco, Inc.
2. Construction Specialties, Inc.
3. EMSEAL Corporation.
4. JointMaster/InPro Corporation.

B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.

C. Wall-to-Wall EJ-3:

1. Design Criteria:

a. Nominal Joint Width: As indicated on Drawings.
b. Movement Capability: -25 percent/+25 percent.
c. Type of Movement: Thermal.

2. Type: Preformed cellular foam.

a. Foam Material: Manufacturer's standard.

1) Color: As selected by Architect from manufacturer's full range.

D. Wall Corner EJ-2:

1. Design Criteria:

a. Nominal Joint Width: As indicated on Drawings.
b. Movement Capability: -25 percent/+25 percent.
c. Type of Movement: Thermal.

2. Type: Preformed cellular foam.

a. Foam Material: Manufacturer's standard.

1) Color: As selected by Architect from manufacturer's full range.

E. Wall Corner, Below Grade EJ-1:

1. Design Criteria:

a. Nominal Joint Width: As indicated on Drawings.

b. Movement Capability: -25 percent/+25 percent.
c. Type of Movement: Thermal.

2. Type: Preformed cellular foam.

a. Foam Material: Manufacturer's standard.

1) Color: As selected by Architect from manufacturer's full range.

2.5 MATERIALS

A. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304 for plates, sheet, and strips.

1. Remove tool and die marks and stretch lines or blend into finish.

B. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required fire-resistance rating.

C. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.

D. Moisture Barrier: Flexible elastomeric material, Santoprene.

E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

F. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion control systems will be installed for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion control system manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion control systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion control systems.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion control systems and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion control systems.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify Architect where discrepancies occur that will affect proper expansion control system installation and performance.
3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
4. Repair or grout blockout as required for continuous frame support using nonmetallic, shrinkage-resistant grout.
5. Install frames in continuous contact with adjacent surfaces.

    a. Shimming is not permitted.

6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.

C. Foam Seals: Install with adhesive recommended by manufacturer.

D. Terminate exposed ends of expansion control systems with field- or factory-fabricated termination devices.

E. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion control system materials and associated work so complete assemblies comply with assembly performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

3.4 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion control systems. Reinstall cover plates or seals prior to Substantial Completion of the Work.

END OF SECTION 079500

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard hollow metal doors and frames.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
2. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
3. Division 08 Section "Fire Rated Glazing" for fire resistance rated glazing and frame assemblies.
4. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.
5. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Samples for Verification:

1. For the following items, prepared on Samples about 12 by 12 inches to demonstrate compliance with requirements for quality of materials and construction:

a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow metal panels and glazing if applicable.

D. Other Action Submittals:

1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

C. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Label each individual glazed lite.

D. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

E. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to finish of factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.9 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amweld Building Products, LLC.
2. Curries Company; an Assa Abloy Group company.
3. Steelcraft; an Ingersoll-Rand company.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Glazing: Comply with requirements in Division 08 Section "Glazing."

J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.

1. Design: Flush panel.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.

    a. Fire Door Core: As required to provide fire-protection ratings indicated.
    b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 11 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

        1) Locations: Exterior doors.

3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
4. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.
5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick, end closures or channels of same material as face sheets.
6. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless).

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless).

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated from metallic-coated steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as full profile welded unless otherwise indicated.
3. Frames for Level 3 Steel Doors: 0.053-inch- thick steel sheet.

C. Interior Frames: Fabricated from cold-rolled steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as full profile welded unless otherwise indicated.
3. Frames for Level 3 Steel Doors: 0.053-inch- thick steel sheet.
4. Frames for Wood Doors: 0.053-inch- thick steel sheet.
5. Frames for Borrowed Lights: 0.053-inch- thick steel sheet.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.6 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.7 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.8 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Glazed Lites: Factory cut openings in doors.
3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Two anchors per jamb up to 60 inches high.
2) Three anchors per jamb from 60 to 90 inches high.
3) Four anchors per jamb from 90 to 120 inches high.
4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches high.
2) Four anchors per jamb from 60 to 90 inches high.
3) Five anchors per jamb from 90 to 96 inches high.

4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.

6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow metal work.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.9 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable glazing stops located on secure side of opening.
    d. Install door silencers in frames before grouting.
    e. Remove temporary braces necessary for installation only after frames have been properly set and secured.

f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
6. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

SECTION 081116 – ALUMINUM MONUMENTAL STILE AND RAIL DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Exterior and interior manual-swing entrance doors.

B. Related Sections:

1. Section 084413 "Glazed Aluminum Curtain Walls" for curtain-wall system framing to receive doors.

1.3 DEFINITIONS

A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Provide door assemblies that have been designed and fabricated to comply with specified performance requirements, as demonstrated by testing manufacturer's corresponding standard systems.

B. Uniform Structural Load: For a single door, test specimen shall be tested in accordance with ASTM E 330: Plus or minus 67.5 pounds per square foot.

C. Air Infiltration: Provide aluminum flush entry doors with maximum air leakage through fixed glazing and framing areas of 0.28 cfm/sq. ft. when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.

D. Condensation Resistance: Provide aluminum flush entry doors with fixed glazing having a condensation-resistance factor (CRF) of not less than 45 when tested according to AAMA 1503.

E. Thermal Conductance: Provide aluminum flush entry doors with fixed glazing and framing areas having an average U-factor of not more than 0.57 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

F. Indoor air quality testing per ASTM D 6670-01: GREENGUARD Environmental Institute Certified including GREENGUARD for Children and Schools Certification.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.

B. LEED Submittal:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside of the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For aluminum monumental stile and rail doors. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

2. Include details to illustrate coordination with adjacent curtain wall framing members.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

1.6 INFORMATIONAL SUBMITTALS

A. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum monumental stile and rail doors to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

C. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

D. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

E. Preinstallation Conference: Conduct conference at Project site.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including, but not limited to, excessive deflection.
   b. Noise or vibration caused by thermal movements.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. Water leakage through fixed glazing and framing areas.
   e. Failure of operating components.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: 20 years from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

A. Entrance Door Hardware:

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Special-Lite, Inc., PO Box 6, Decatur, Michigan 49045.
   a. Toll Free (800) 821-6531. Phone (269) 423-7068. Fax (800) 423-7610.
   b. Web Site www.special-lite.com.
   c. E-Mail info@special-lite.com.MATERIALS

2.2 MONUMENTAL STILE AND RAIL DOORS

A. Model: SL-14 medium stile monumental aluminum stile and rail doors.

B. Door Opening Size: As indicated on the Drawings.

C. Door Thickness: 1-3/4 inches.

D. Stiles and Rails:
1. Material: Aluminum extrusions made from prime-equivalent billet that is produced from 100% reprocessed 6063-T5 alloy recovered from industrial processes, 0.125-inch minimum wall thickness, 1-piece.
2. Stile Width: 3-5/8 inches.
3. Rail Width:
   a. Top: 6-1/2 inches.
   b. Bottom: 10 inches.

E. Corners:
1. True mortise and tenon joints.
2. Full-width 3/8-inch diameter galvanized steel tie rods secured with locking hex nuts.

F. Welding of Joints: Not permitted.

G. Mid Rail:
1. Width: 4 inches.
2. One-piece extrusion with integral exterior glass stops.
3. Secure to vertical stiles with mortise and tenon joints and 3/8-inch diameter galvanized steel tie rod with locking hex nuts.

2.3 MATERIALS

A. Aluminum Members:
1. Aluminum extrusions made from prime-equivalent billet that is produced from 100% reprocessed 6063-T5 alloy recovered from industrial processes: ASTM B 221.
2. Sheet and Plate: ASTM B 209.
3. Wall Thickness: 0.125 inch.
4. Alloy and Temper: As required by manufacturer for strength, corrosion resistance, application of required finish, and control of color.

B. Fasteners:
1. Material: Aluminum, 18-8 stainless steel, or other noncorrosive metal.
2. Compatibility: Compatible with items to be fastened.
3. Exposed Fasteners: Oval Phillips head screws with finish matching items to be fastened.

2.4 FABRICATION

A. Sizes and Profiles: Required sizes for door and frame units and profile requirements shall be as indicated on the Drawings.

B. Coordination of Fabrication: Field measure before fabrication and show recorded measurements on shop drawings.

C. Assembly:
1. Complete cutting, fitting, forming, drilling, and grinding of metal before assembly.
2. Remove burrs from cut edges.

D. Welding: Welding of doors or frames is not acceptable.

E. Fit:
   1. Maintain continuity of line and accurate relation of planes and angles.
   2. Secure attachments and support at mechanical joints with hairline fit at contacting members.

2.5 HARDWARE

A. Premachine doors in accordance with templates from specified hardware manufacturers and hardware schedule.

B. Factory install hardware.

C. Hardware Schedule: As specified in Section 08 71 00.

2.6 GLAZING

A. Factory Glazing: 1-inch glass insulating units.

B. Design glazing system for replacement of glass.

C. Manufacturer's standard flush glazing system of recessed channels and captive glazing gaskets.

D. Allow for thermal expansion on exterior units.

2.7 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Section 079200 "Joint Sealants."

   1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.8 ALUMINUM FINISHES

A. High-Performance Organic Finish: 4-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   1. Color and Gloss: Match adjacent curtain wall framing system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Section 088000 "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

H. Install perimeter joint sealants as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

3.3 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
2. Alignment:

a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

3.4 ADJUSTING

A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.

1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge.

END OF SECTION 081116

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Sections:

1. Division 06 Section “Interior Architectural Woodwork" for wood door frames and trim.
2. Division 06 Section “Flush Wood Paneling” for wood-veneer wall surfacing from the same flitches for both flush wood doors and wood paneling.
3. Division 08 Section "Glazing" for glass view panels in flush wood doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door indicated. Include details of core and edge construction and trim for openings.

B. LEED Submittals:

1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that flush wood doors comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
2. Product Data for Credit IEQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.
3. Laboratory Test Reports for Credit IEQ 4: For adhesives and composite wood products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.

1. Indicate dimensions and locations of mortises and holes for hardware.
2. Indicate dimensions and locations of cutouts.
3. Indicate requirements for veneer matching.

4. Indicate fire-protection ratings for fire-rated doors.

D. Samples for Verification:

1. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.

a. Provide samples for each species of veneer and solid lumber required.
b. Provide samples for each color, texture, and pattern of plastic laminate required.
c. Finish veneer-faced door samples with same materials proposed for factory-finished doors.

2. Frames for light openings, 6 inches long, for each material, type, and finish required.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Source Limitations: Obtain flush wood doors and wood paneling from single manufacturer.

C. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated."

D. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at according to NFPA 252 or UL 10C.

E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Algoma Hardwoods, Inc.
2. Marshfield Door Systems, Inc.
3. Mohawk Flush Doors, Inc.; a Masonite company.

2.2 DOOR CONSTRUCTION, GENERAL

A. Certified Wood: Fabricate doors with all wood products produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

C. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.

1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Comply with specified requirements for exposed edges.

D. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces.
2. Species: Select white maple and white oak where indicated.
3. Where wood veneer doors occur in a room with wood veneer paneling, the interior faces of the wood doors shall be veneered from the same flitch as the room side wood paneling.
4. Cut:

    a. Maple: Plain sliced (flat sliced).
    b. White Oak: Quarter sliced with medium flake.

5. Match between Veneer Leaves: Book match.
6. Assembly of Veneer Leaves on Door Faces: Balance match.
7. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
8. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Division 06 Section "Flush Wood Paneling."
9. Core: Either glued wood stave or structural composite lumber.
10. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.
11. WDMA I.S.1-A Performance Grade: Heavy Duty.

2.4 LIGHT FRAMES

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Manufacturer's standard shape.

B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

1. Round Glass Vision Lites: Provide round metal frames for use with fire and safety rated glass to achieve the protection rating indicated.

    a. Manufacturer: Anemostat Door Products, A Mestek Company.

2.5 FABRICATION

A. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

B. Openings: Cut and trim openings through doors in factory.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing."

2.6 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory.

C. Transparent Finish:

1. Grade: Premium.
2. Finish: AWI catalyzed vinyl TR-5 system.
3. Staining: As selected by Architect from manufacturer's full range.
4. Effect: Filled finish.
5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Division 08 Section "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.

1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.

    a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
3. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083323 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulated service doors.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.
2. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for finish painting of factory-primed doors.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design overhead coiling doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance, Exterior Doors: Exterior overhead coiling doors shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.

1. Wind Loads: As indicated on Drawings.
2. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.

C. Operability under Wind Load: Design overhead coiling doors to remain operable under design wind load, acting inward and outward.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:

1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Delegated-Design Submittal: For overhead coiling doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Summary of forces and loads on walls and jambs.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling door manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

PART 2 - PRODUCTS

2.1 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch and as required to meet requirements.
2. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection rated glass as required for type of door; set in glazing channel secured to curtain slats.

3. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within slat faces.
4. Gasket Seal: Provide insulated slats with manufacturer's standard interior-to-exterior thermal break or with continuous gaskets between slats.

B. Endlocks for Service Doors: Malleable-iron casings galvanized after fabrication, secured to curtain slats with galvanized rivets or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.

C. Bottom Bar for Service Doors: Consisting of two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.

D. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.

E. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.2 LOCKING DEVICES

A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: Provide cylinders specified in Section 087100 "Door Hardware".
2. Keys: Provide three for each cylinder.

B. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.3 CURTAIN ACCESSORIES

A. Weatherseals: Equip each exterior door with weather-stripping gaskets fitted to entire perimeter of door for a weathertight installation, unless otherwise indicated.

1. At door head, use 1/8-inch- thick, replaceable, continuous sheet secured to inside of hood.
2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene.

B. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

1. Provide pull-down straps or pole hooks for doors more than 84 inches high.

2.4 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a

spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.

C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.5 MANUAL DOOR OPERATORS

A. For door 001C.3.

B. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.

C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25 lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

D. Locking Devices: Equip door with locking device assembly.

1. Locking Device Assembly: Single-jamb side locking bars, operable from inside with thumb turn.

2.6 ELECTRIC DOOR OPERATORS

A. For door 079Z.2 .

B. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.

C. Door Operator Location(s): Operator location indicated for each door.

1. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.

D. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 110513 "Common Motor Requirements for Equipment" unless otherwise indicated.

1. Electrical Characteristics:

a. Phase: Single phase.
b. Volts: 115 V.
c. Hertz: 60.

2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
3. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
5. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

G. Remote-Control Station: Card reader activated momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."

1. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
2. Door operation to interlock with card reader and access control system.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

2.7 DOOR ASSEMBLY

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cookson Company.
    b. Overhead Door Corporation.
    c. Raynor.

B. Curtain R-Value: 6.0 deg F x h x sq. ft./Btu.

C. Door Curtain Material: Galvanized steel.

D. Door Curtain Slats: Flat profile slats of 2-5/8-inch center-to-center height.

1. Vision Panels: Approximately 10- by 1-5/8-inch openings spaced approximately 2 inches apart and beginning 12 inches from end guides; in three rows of slats at height indicated on Drawings; installed with insulated vision-panel glazing.

E. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.

F. Electric Door Operator: Motorized door operator with card reader access control at door 079Z.2 only.

1. Usage Classification: Standard duty, up to 60 cycles per hour.
2. Operator Location: Front of hood.
3. Motor Exposure: Interior.
4. Emergency Manual Operation: Push-up type.
5. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar.

G. Manual Door Operator: At door 001C.3.

1. Provide operator with through-wall shaft operation.

H. Door Finish:

1. Factory Prime Finish: Manufacturer's standard color.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 STEEL AND GALVANIZED-STEEL FINISHES

A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide weathertight fit around entire perimeter.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 083323

SECTION 084120 – INTERIOR ALUMINUM DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior aluminum framing.
2. Interior aluminum manual-swing doors.

B. Related Requirements:

1. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
2. Division 08 Section "Fire Rated Glazing" for fire resistance rated glazing and frame assemblies.
3. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For aluminum-framed assemblies. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed storefronts, showing the following:

a. Joinery, including concealed welds.

b. Anchorage.
c. Glazing.

3. Show connection to and continuity with adjacent construction.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Glazing.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed storefronts to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.8 WARRANTY

s.

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.

b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Failure of operating components.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Glass breakage.
b. Noise or vibration created by structural movements.
c. Loosening or weakening of fasteners, attachments, and other components.
d. Failure of operating units.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. EFCO Corporation.
2. Kawneer North America.
3. Oldcastle BuildingEnvelope.
4. Tubelite.
5. United States Aluminum.
6. YKK AP America Inc.

B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.3 FRAMING

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Nonthermal.
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Glazing Plane: Center.
4. Finish: High-performance organic finish.
5. Fabrication Method: Field-fabricated stick system.

B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Materials:

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

a. Sheet and Plate: ASTM B 209.
b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
d. Structural Profiles: ASTM B 308/B 308M.

2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 DOORS

A. Doors: Manufacturer's standard glazed doors for manual-swing operation.

1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

2. Door Design: As indicated.
3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.

a. Provide nonremovable glazing stops on outside of door.

2.5 DOOR HARDWARE

A. Door Hardware: Hardware is specified in Section 087100 "Door Hardware."

B. General: Provide hardware for each entrance door to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color specified in Section 087100 "Door Hardware."
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Opening-Force Requirements:

a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion.
b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

2.6 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

D. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L.

2.7 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

C. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

D. Doors: Reinforce doors as required for installing entrance door hardware.

E. Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF or FEVE resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components plumb and true in alignment with established lines and grades.

D. Install glazing as specified in Section 088000 "Glazing."

E. Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Door Hardware: Install surface-mounted door hardware according to door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install aluminum-framed storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:

a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

END OF SECTION 084120

SECTION 084123 - FIRE RATED GLASS AND ALUMINUM FRAMED DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fire rated glazing and framing systems for installation as fire rated door assemblies, including vision lights in fire rated doors, sidelights and transoms, in interior openings.

B. Related Requirements:
   1. Section 078446 “Fire-Resistive Joint Systems” for firestops between work of this section and other fire resistive assemblies.
   2. Section 087100 “Door Hardware” for door hardware other than that provided by the work of this section

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 PERFORMANCE REQUIREMENTS

A. Fire Rating Requirements:
   1. Duration:
      a. Doors: Capable of providing a fire rating for 60 minutes.
      b. Sidelights and tramsoms: Capable of providing a fire rating for 60 minutes.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

   2. Laboratory test data.

B. LEED Submittals:

   1. Product Data for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's "Standard

Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Shop Drawings: For fire rated aluminum-framed assemblies, include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed storefronts, showing the following:

   a. Joinery, including concealed welds.
   b. Anchorage.
   c. Glazing.
3. Show connection to and continuity with adjacent construction. Provide templates for the location of embeds and anchor locations required for any adjoining work

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Glazing.

G. Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

H. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

1.6 INFORMATIONAL SUBMITTALS

A. Technical Information: Submit latest edition of manufacturer’s product data providing product descriptions, technical data and installation instructions. Including blank warranty form.

B. Installer Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Manufacturer’s Certificate.

D. Warranties: Submit manufacturer’s warranty and ensure that forms have been completed in the Owner’s name and registered with the manufacturer.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire rated aluminum-framed storefronts to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

C. Source Limitations for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated..

D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by UL, for fire ratings indicated, based on testing according to NFPA 252. Door assembly must be factory-welded or come complete with factory-installed mechanical joints and must not require job site fabrication.

E. Certification: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
1. Door assemblies shall be tested to the acceptance criteria of ASTM E2074-00, NFPA 252, UL 9, UL 10-C Standard Methods of Fire Tests of Door Assemblies.

F. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by an approved independent agency maintaining a current listing or certification. Label assemblies accordance with limits of manufacturer’s listing.

G. Door assemblies shall be marked with the hourly rating followed by the letter "S". The letter "S" indicates air leakage resistance testing conformance to UBC 7-2 Parts I and II.

H. Regulatory Requirements: Comply with provisions of the following:
1. Comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," as follows:
a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
b. Door Closers: Comply with the following maximum opening-force requirements indicated:
1) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

NFPA 101: Comply with the following for means of egress doors:
a. Latches, Locks, and Exit Devices: Not more than 15 lbf (67 N) to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.

b. Door Closers: Not more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle under provisions specified by manufacturer.

1.10 PROJECT CONDITIONS

A. Obtain field measurements prior to fabrication of frame units. If field measurements will not be available in a timely manner coordinate planned measurements with the work of other sections.

1. Note whether field or planned dimensions were used in the creation of the shop drawings.

B. Coordinate the work of this section with others effected including but not limited to: other exterior envelope components and door hardware beyond that provided by this section

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Failure of operating components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. SaftiFirst.
2. Technical Glass Products.
3. Vetrotech - Saint-Gobain.

B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 MATERIALS – GLASS

A. Fire Rated Glazing: Composed of multiple sheets of low iron, high-visible-light transmission glass laminated with an intumescent interlayer.

B. Impact Safety Resistance: ANSI Z97.1 and CPSC 16CFR1201 (Cat. I and II).

C. Properties Interior Glazing:

1.	Fire Rating	60 minute.
2.	Glazing type	Single.
3.	Daylight Transmission	Min. 85%.
4.	Sound Transmission Coefficient	41dB.

D. Logo: Each piece of fire-rated glazing shall be labeled with a permanent logo including name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.

E. Glazing Accessories: Manufacturer's standard compression gaskets, spacers, setting blocks and other accessories necessary for a complete installation.

2.3 MATERIALS –ALUMINUM FRAMING

A. Aluminum Framing System 60 min.

1. Steel Frame: The steel framing members are made of two halves, nom. 1.916 in. wide with a nom. minimum depth of 1.3 in. with lengths cut according to glazing size.
2. Aluminum Trim **—** Supplied with the steel framing members. Nom. 1-916 in. wide with a nom. depth of 1.3 in. with lengths cut according to glazing size.
3. Stainless Steel Spacers — supplied with the steel framing members. Nom 3/8 in. diameter with a nom. minimum depth of 1-1/16 in. with depth adjusted to match glass thickness.
4. Framing Member Fasteners — supplied with the steel framing members. Screws have a nom. ¼ in. diameter with a minimum length of 2.363 in. Screws to be sized to accommodate the thickness of the fire resistant glazing material.
5. Glazing Tape — Supplied with the steel framing members. Nom. ½ in. by ¼ in. closed cell PVC glazing tape applied to the steel framing members to cushion and seal the glazing material when installed.

2.4 MATERIALS – DOORS

A. Manufacturer's standard [single leaf] and [double leaf] door[s] with manufacture's standard hardware.

B. Coordinate door hardware with cylinder specified in Section 087100 Hardware.

2.5 FABRICATION

A. Field glaze door and frame assemblies.

B. Factory prepare steel door assemblies field mounting of hardware.

C. Fabrication Dimensions: Fabricate fire rated assembly to field dimensions.

D. Obtain reviewed Shop Drawings prior to fabrication.

2.6 DOOR HARDWARE

A. Furnish hardware with 60 minute fire door by the manufacturer. Select hardware from door manufacturer's standard recommended and approved hardware groups as specified in Division 8 Section "Door Hardware".
   1. All hardware BHMA Certified

B. Operating hardware for Active-Active Pair of Doors with Exit Device Outswing. Each pair to have the following.

	Item	Description	Manufacturer	Finish
6	Hanging Devices	Weld on Pivots	Technical Glass Products	PTM
2	Exit Device	9847L-F x 996L-BE	Von Duprin	630
2	Lever Trim	Rectangular lever handles	Technical Glass Products	630
1	Cylinder	ANSI Mortise Schlage C Keyway	Technical Glass Products	626
2	Closing Devices	T4041 x 180-degrees (P4041-EDA at Door #0SD.1)	LCN	689
2	Auto door Bottoms	420APKL Smoke Seal	Pemko	MA
1	Weather Seal	Perimeter Gasket	Technical Glass Products	
	Balance of hardware by others			

2.7 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

2.8 ALUMINUM FINISHES

A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF or FEVE resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Install fully fire rated door assemblies in strict accordance with the approved shop drawings.
3. Do not install damaged components.
4. Fit joints to produce hairline joints free of burrs and distortion.
5. Rigidly secure nonmovement joints.
6. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
7. Install fire safing / fire stopping at edges of system
8. Install glazing in strict accordance with fire resistant glazing material manufacturer's specifications. Field cutting or tampering is not permissible.
9. Seal perimeter and other joints.

B. Install components plumb and true in alignment with established lines and grades.

C. Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Door Hardware: Install surface-mounted door hardware according to door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install aluminum-framed storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:

   a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
   b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
   c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

END OF SECTION 084123

SECTION 084124 - FIRE RATED GLASS AND STEEL FRAMED DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fire rated glazing and framing systems for installation as fire rated door assemblies, including vision lights in fire rated doors, sidelights and transoms, in interior openings.

B. Related Requirements:
   1. Section 078446 “Fire-Resistive Joint Systems” for firestops between work of this section and other fire resistive assemblies.
   2. Section 087100 “Door Hardware” for door hardware other than that provided by the work of this section

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 PERFORMANCE REQUIREMENTS

A. Fire Rating Requirements:
   1. Duration:
      a. Doors: Capable of providing a fire rating for 90 minutes.
      b. Sidelights and transoms: Capable of providing a fire rating for 90 minutes.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

   2. Laboratory test data.

B. LEED Submittals:

   1. Product Data for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's "Standard

Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Shop Drawings: For fire rated aluminum-framed assemblies, include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed storefronts, showing the following:

   a. Joinery, including concealed welds.
   b. Anchorage.
   c. Glazing.
3. Show connection to and continuity with adjacent construction. Provide templates for the location of embeds and anchor locations required for any adjoining work

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Glazing.

G. Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

H. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

1.6 INFORMATIONAL SUBMITTALS

A. Technical Information: Submit latest edition of manufacturer’s product data providing product descriptions, technical data and installation instructions. Including blank warranty form.

B. Installer Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Manufacturer’s Certificate.

D. Warranties: Submit manufacturer’s warranty and ensure that forms have been completed in the Owner’s name and registered with the manufacturer.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire rated aluminum-framed storefronts to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

C. Source Limitations for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated..

D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by UL, for fire ratings indicated, based on testing according to NFPA 252. Door assembly must be factory-welded or come complete with factory-installed mechanical joints and must not require job site fabrication.

E. Certification: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
1. Door assemblies shall be tested to the acceptance criteria of ASTM E2074-00, NFPA 252, UL 9, UL 10-C Standard Methods of Fire Tests of Door Assemblies.

F. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by an approved independent agency maintaining a current listing or certification. Label assemblies accordance with limits of manufacturer’s listing.

G. Door assemblies shall be marked with the hourly rating followed by the letter "S". The letter "S" indicates air leakage resistance testing conformance to UBC 7-2 Parts I and II.

H. Regulatory Requirements: Comply with provisions of the following:
1. Comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," as follows:
a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
b. Door Closers: Comply with the following maximum opening-force requirements indicated:
1) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

NFPA 101: Comply with the following for means of egress doors:
a. Latches, Locks, and Exit Devices: Not more than 15 lbf (67 N) to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.

b. Door Closers: Not more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle under provisions specified by manufacturer.

1.10 PROJECT CONDITIONS

A. Obtain field measurements prior to fabrication of frame units. If field measurements will not be available in a timely manner coordinate planned measurements with the work of other sections.

1. Note whether field or planned dimensions were used in the creation of the shop drawings.

B. Coordinate the work of this section with others effected including but not limited to: other exterior envelope components and door hardware beyond that provided by this section

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Failure of operating components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. SaftiFirst.
2. Technical Glass Products.
3. Vetrotech - Saint-Gobain.

B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 MATERIALS – GLASS

A. Fire Rated Glazing: Composed of multiple sheets of low iron, high-visible-light transmission glass laminated with an intumescent interlayer.

B. Impact Safety Resistance: ANSI Z97.1 and CPSC 16CFR1201 (Cat. I and II).

C. Properties Interior Glazing:

1.	Fire Rating	90 minute.
2.	Glazing type	Single.
3.	Daylight Transmission	Min. 85%.
4.	Sound Transmission Coefficient	41dB.

D. Logo: Each piece of fire-rated glazing shall be labeled with a permanent logo including name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.

E. Glazing Accessories: Manufacturer's standard compression gaskets, spacers, setting blocks and other accessories necessary for a complete installation.

2.3 MATERIALS – STEEL FRAMING

A. Steel Framing System 90 min:
1. Steel Frame: Profiled steel tubing permanently joined with steel bolts.
2. Insulation: Insulate framing system against effects of fire, smoke, and heat transfer from either side. Insulate profiled steel tubing using a shell construction that incorporates Promatect-H intermediate interlayer. Firmly pack perimeter of framing system to rough opening with mineral wool fire stop insulation or appropriately rated intumescent sealant.
3. Frame meets Bullet resistance rating Level 8 per UL 752
4. Steel Glazing Beads: Extruded steel beads with dimensions recommended by manufacturer to securely hold glazing material in place.
5. Fasteners: Type recommended by manufacturer
6. Glazing Accessories: Set Pilkington Pyrostop glass using calcium silicate, or setting blocks.
7. Glazing Gaskets, Compounds and tapes: Glaze fire rated glass with approved EPDM glazing gaskets and closed cell PVC tape, or pure silicone sealant.

2.4 MATERIALS – DOORS

A. Manufacturer's standard double leaf doors with manufacture's standard hardware.

B. Coordinate doors with electronic security hardware specified in Section 087100 Hardware.

2.5 FABRICATION

A. Furnish interior frame assemblies pre-welded.
1. When necessary, splice frames too large for shop fabrication or shipping or to fit in available building openings.
2. Fit with suitable fasteners.
3. Knock-down door perimeter frames are not permitted

B. Field glaze door and frame assemblies.

C. Factory prepare steel door assemblies field mounting of hardware.

D. Fabrication Dimensions: Fabricate fire rated assembly to field dimensions.

E. Obtain reviewed Shop Drawings prior to fabrication.

2.6 DOOR HARDWARE

A. Furnish hardware with 90 minute fire door by the manufacturer. Select hardware from door manufacturer's standard recommended and approved hardware groups as specified in Division 8 Section "Door Hardware".

1. All hardware BHMA Certified

B. Operating hardware for Active-Active Pair of Doors with Exit Device Outswing. Each pair to have the following.

	Item	Description	Manufacturer	Finish
6	Hanging Devices	Weld on Pivots	Technical Glass Products	PTM
2	Exit Device	Per hardware group specified in 087100 "Door Hardware"	Von Duprin	630
2	Lever Trim	Rectangular lever handles	Technical Glass Products	630
1	Cylinder	ANSI Mortise Schlage C Keyway	Technical Glass Products	626
2	Closing Devices	Per hardware group specified in 087100 "Door Hardware"	LCN	689
2	Auto door Bottoms	420APKL Smoke Seal	Pemko	MA
1	Weather Seal	Perimeter Gasket	Technical Glass Products	

Balance of hardware by others

2.7 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish frames after assembly.

C. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable. Noticeable variations in the same piece are not acceptable.

2.9 FACTORY FINISHES

A. Color-Coated Finish: Apply manufacturer's standard powder coating finish system complying with AAMA 2603 applied to factory-assembled frames before shipping, complying with manufacturer's written instructions for surface preparation including pretreatment, application, and minimum dry film thickness.
   1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

   1. Comply with manufacturer's written instructions.
   2. Install fully fire rated door assemblies in strict accordance with the approved shop drawings.
   3. Do not install damaged components.
   4. Fit joints to produce hairline joints free of burrs and distortion.
   5. Rigidly secure nonmovement joints.
   6. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   7. Install fire safing / fire stopping at edges of system
   8. Install glazing in strict accordance with fire resistant glazing material manufacturer’s specifications. Field cutting or tampering is not permissible.
   9. Seal perimeter and other joints.

B. Install components plumb and true in alignment with established lines and grades.

C. Doors: Install doors to produce smooth operation and tight fit at contact points.

   1. Door Hardware: Install surface-mounted door hardware according to door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install aluminum-framed storefronts to comply with the following maximum tolerances:

   1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.

2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:

    a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

END OF SECTION 084124

SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Glazed aluminum curtain walls installed as stick assemblies.
2. Sun control devices.

B. Related Sections:

1. Section 079200 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls.
2. Section 081116 “Aluminum Monumental Stile And Rail Doors” for doors.
3. Section 088000 “Glazing” for glazing in aluminum framed curtain walls.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

B. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.

D. Structural-Test Performance: Test according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch, whichever is smaller.

    a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.

F. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..

G. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..

1. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.

H. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
2. Test Interior Ambient-Air Temperature: 75 deg F.
3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

I. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.37 as determined according to NFRC 200.

3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.10 cfm/sq. ft. of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft..
4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than 45 as determined according to NFRC 500.

J. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:

1. Outdoor-Indoor Transmission Class: Minimum 34 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

K. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
3. Structural-Sealant Joints:

    a. Designed to carry gravity loads of glazing.
    b. Designed to produce tensile or shear stress of less than 20 psi.
    c. Design reviewed and approved by structural-sealant manufacturer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For glazing sealants used inside of the weatherproofing system, documentation including printed statement of VOC content.

C. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.

2. Submit shop drawings for sun control devices showing layout, profiles, and product components, including anchorage, accessories, finish colors and textures.

3. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:

    a. Joinery, including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.

e. Flashing and drainage.

4. Include laboratory mockup Shop Drawings, prepared by a qualified preconstruction testing agency, showing details of laboratory mockup.

a. Resubmit Shop Drawings with changes made to glazed aluminum curtain walls to successfully complete preconstruction testing.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Preconstruction Mockup Submittals:

1. Preconstruction Testing Program: Developed specifically for Project.
2. Preconstruction Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
3. Record Drawings: Submit record drawings of preconstruction mockups prepared by preconstruction testing agency.

B. Qualification Data: For qualified Installer and testing agency.

C. Welding certificates.

D. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified preconstruction testing agency, for glazed aluminum curtain walls, indicating compliance with performance requirements.

F. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

E. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of structural sealant-glazed curtain walls.

F. Energy Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.

1. Provide NFRC-certified glazed aluminum curtain walls with an attached label.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings. Include sun control device as indicated.
2. Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

H. Preinstallation Conference: Conduct conference at Project site.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Assembly Warranty: Standard form in which manufacturer agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.

b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Tubelite.
2. Schuco USA LP.
3. YKK AP America Inc.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B 209.
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING

A. Framing Members: Manufacturer's standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Thermally broken.
2. Glazing System: Retained mechanically with gaskets on vertical sides, structurally glazed horizontal mullions as indicated.
3. Glazing Plane: Front.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.

D. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

E. Concealed Flashing: Dead-soft, 0.018-inch- thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.

F. Framing Sealants: Manufacturer's standard sealants.

2.4 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers. Comply with Section 088000 "Glazing."

C. Glazing Sealants: As recommended by manufacturer.

1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 OPERABLE UNITS

A. Venting Windows: Curtain wall manufacturer’s concealed venting unit coordinated to install within the curtain wall framing.

1. System performance: same as for curtain wall.

B. Doors: Comply with Section 081116 “Aluminum Monumental Stile And Rail Doors”.

2.6 SUN CONTROL DEVICES

A. Sun Shades: Provide fixed aluminum shading device by same manufacturer as the curtain wall framing.

1. Sunshade to consist of outriggers, louvers, and fascia anchored directly to the vertical curtain wall mullions.

   a. Outrigger type: Straight tapered.
   b. Blade type: Airfoil profile.
   c. Fascia: Curved Profile.

2. All structural components and attachment hardware shall be concealed.

3. Sunshade anchor must be designed and installed so as to avoid thermal bridging of the curtain wall framing system. Installed sun shades shall not impede curtain wall internal drainage system.

2.7 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Fabricate components that, when assembled, have the following characteristics:

1. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

2.9 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three or Four-coat fluoropolymer finish as required to obtain selected color, complying with AAMA 2605 and containing not less than 70 percent

PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss**;**

   a. Curtain Wall Type 1: Valspar Industrial Coating 391A623 Fluropon Bone White with clear coat.
   b. Curtain Wall Type 2: Valspar Industrial Coating SL9A300 Fluropon Classic Champagne Metallic with clear coat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
7. Seal joints watertight unless otherwise indicated.

B. Sun Shades:

1. Install sun shades in accordance with approved shop drawings using manufacturer standard concealed anchorage.
2. Shop fabricate and assemble units with joints only at intersection of aluminum members, with hairline joints rigidly secured in accordance with manufacturer’s recommendations.
3. Adjust airfoil louvers to optimize shading for peak cooling conditions.

C. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

E. Install components plumb and true in alignment with established lines and grades.

F. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

G. Install glazing as specified in Section 088000 "Glazing."

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:

    a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.4 FIELD QUALITY CONTROL

A. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.

1. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft., of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft.

    a. Test Area: Perform initial test on the project mock up for curtain wall installation in masonry and in metal framed wall.

        1) In the event of failure, rework and adjust mock up wall and retest until the assembly oases.

    b. Conduct a minimum of three additional tests on installed curtain wall in areas as directed by Architect. Test areas to be a minimum of three bays wide by height of assembly. Perform tests at approximately 35, 70 and 100 per cent completion of curtain wall installation.

2. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.

a. Test Area: Perform initial test on the project mock up for curtain wall installation in masonry and in metal framed wall.

1) In the event of failure, rework and adjust mock up wall and retest until the assembly passes.

b. Conduct a minimum of three additional tests over the course of the work on installed curtain wall in areas as directed by Architect. Test areas to be a minimum of three bays wide by height of assembly. Perform tests at approximately 35, 70 and 100 per cent completion of curtain wall installation.

3. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

a. Test Areas: A minimum of four test areas, each a minimum of three bays wide by full height of the curtain wall.

1) West façade, curtain wall designation HH.
2) West façade, Stair D glazing, curtain wall designation N.
3) North façade glazing, curtain wall designation Z.
4) Atrium clerestory glazing, northwest corner, curtain wall designations DD and JJ.

B. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 084413

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:
   1. Commercial door hardware for the following:
      a. Swinging doors.
      b. Other doors to the extent indicated.
   2. Electrified door hardware.

B. Related Sections:
   1. Division 08 Section "Hollow Metal Doors and Frames" for steel doors and frames including astragal requirements for pairs of doors.
   2. Division 08 Section "Aluminum Monumental Stile and Rail Doors" for aluminum storefront door and frame requirements.
   3. Division 08 Section "Flush Wood Doors" for wood doors including special stile and rail construction for application of hardware without through bolts.
   4. Division 08 Section "Overhead Coiling Doors" for hardware requirements at coiling doors for the application of cylinders
   5. Division 08 Section "Fire Rated Aluminum Framed Door Assemblies" for hardware requirements at fire rated aluminum framed doors.
   6. Division 08 Section "Fire Rated Steel Framed Door Assemblies" for hardware requirements at fire rated steel framed doors.
   7. Division 26 Sections for electrical power system and line-voltage wiring work.
   8. Division 28 Sections for access control devices installed at door openings provided as part of a security access system
   9. Division 28 Sections for connections to building fire alarm system.

1.3 REFERENCES

A. The publications listed below, including the amendments, addenda and designated changes, form a part of this specification to the extent referenced.
   1. Federal Specifications (FS): FF-H-111C-74 Hardware, Builders Shelf and Miscellaneous.
   2. National Fire Protection Association (NFPA):
      a. Standard 70, National Electric Code.
      b. Standard 80, Fire Doors and Other Opening Protective's.
      c. Standard 101, Life Safety Code.
      d. Standard 252, Methods of Fire Tests of Door Assemblies.
   3. American National Standards Institute (ANSI):
      a. A156.6, Architectural Door Trim.
      b. A156.18, Materials and Finishes.
   4. Americans with Disabilities Act (ADA): Accessibility Guideline for Buildings and Facilities.
   5. Door and Hardware Institute (DHI):

a. Keying Systems and Terminology.

b. Abbreviations and Symbols.
c. Recommended Locations for Builder's Hardware for Custom Steel Doors and Frames.

6. Underwriters Laboratories, Inc. (UL): UL-BMD, Building Materials Directory.

1.4 SUBMITTALS

A. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content.
a. Include statement indicating costs for each product having recycled content.
2. Credit MR 5.1 and 5.2: List of proposed regionally manufactured materials and regionally extracted, harvested, or recovered materials.
a. Identify each regionally manufactured material, its source, and cost.
b. Identify each regionally extracted, harvested or recovered material, its source, and cost.
c. Include map or other similar documentation, confirming the following:
1) Driving distance between location of manufacture and Project site.
2) Driving distances between location of extraction, harvesting, or recovery, and Project site.

B. Supplier's Hardware Schedule: Submit a door hardware schedule in accordance with Division 01 in the manner and format prescribed and used herein, complying with the actual construction progress. Hardware schedules are intended for coordination of the work. Review and acceptance by the Architect or Owner does not relieve the Contractor of his exclusive responsibility to fulfill the requirements as shown and specified.
1. Hardware Schedule Content: Based on hardware indicated, organize hardware schedule into Sets or sets showing complete designations of every item required for each door opening. Schedule shall be vertical layout similar to the format used herein. Lines shall be double spaced with pages numbered and dated.
a. For doors of different sizes or where hinges, locks or closers are different, a separate heading shall be used. No labeled openings shall be combined with non-labeled openings. Horizontal hardware schedules are not acceptable. Include the following:
1) Number, location, hand, fire rating, size and material of each door opening (hands and swings to be determined in relation to key side of opening).
2) Type, style, function, size, finish and quantity of each hardware item.
3) Name and manufacturer of each item.
4) Fastening requirements.
5) Explanation of abbreviations used (use nomenclature consistent with DHI's "Abbreviations and Symbols" wherever possible).
6) Special mounting locations and instructions.
2. Combined submittals are not acceptable. Do not combine hardware schedules with door and frame shop drawings.
3. Schedules not adhering to these parameters will not be reviewed.

C. Hardware Schedule Index: Furnish an index cross referencing Contract Document door number and hardware Set, and supplier's hardware set.

D. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

E. Samples for Verification: If requested by the Architect, submit one sample of each type of hardware tagged with full description for coordination with the schedule. These items shall remain on file in the Architect's office until all other similar items have been installed in the project. At that time, items on file will become Owner Maintenance Stock.

F. Product Certificates:
   1. For electrified door hardware, signed by product manufacturer.
   2. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.

G. Qualification Data: Submit supplier and installer qualifications verifying years of experience; include list of completed projects having similar scope of work identified by name, location, date, reference names and phone numbers.

H. Operating Instructions: Furnish the Owner with one complete set of installation instructions, including special adjusting tools and maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Furnish information in Compact Disk form, one for each applicable manufacturer, as well as internet web links for each manufacturer.
   1. One complete catalog shall be furnished for each manufacturer listed in the approved hardware schedule.

I. Templates: Provide necessary templates and/or physical hardware to all trades or factories requiring them so they may cut, reinforce or otherwise prepare their material or product to receive the hardware item. If any manufacturer requires physical hardware, ship to them such hardware via prepaid freight in sufficient time to prevent any delay in the execution of their work.
   1. Include templates for Contractor furnished and Owner furnished and installed security devices that require door and frame preparation for mortised applications.
   2. It is the responsibility of this Contractor to ensure that doors and frames are factory prepared for all door and frame mounted security devices.

J. Warranty: Special warranties specified in this Section.

K. Other Action Submittals: After Hardware Schedule has received Architect’s approval; submit the following:
   1. Keying Schedule: Detailed keying system schedule, indicating Owner’s approved keying system, for Owner’s review and approval. Include the following:
      a. Schematic keying diagram
      b. Index identifying each key set to unique door designations.
      c. Bitting list.
   2. Wiring Diagrams: Details of electrified door hardware. Include fire alarm and/or access control system interface where applicable.
      a. Diagrams shall be complete by opening and shall indicate connections between all components affected. Manufacturers' standard line diagrams are not acceptable. Include the following:
         1) System schematic.
         2) Point-to-point wiring diagram.
         3) Riser diagram.
         4) Elevation of each door.
      b. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

1.5 QUALITY ASSURANCE

A. Contractor: Assign the installation of hardware to tradesmen experienced in the installation of commercial door hardware.

B. Installer Qualifications: An employer of workers trained and approved by the Lock, Door Closer, and Exit Device Manufacturers.
   1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
   2. Installer shall have warehousing facilities in Project's vicinity.
   3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
   4. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

D. Accessibility for Disabled Persons: Special hardware requirements for knurling, slow acting closers or other barrier free opening requirements shall be provided as indicated in the Door Hardware Sets and as required to comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)".

E. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
   1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.

F. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Keying Conference: Conduct conference at Project site. In addition to Owner, Construction Manager, and Contractor, conference participants shall also include Installer's Architectural Hardware Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
   1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
   2. Preliminary key system schematic diagram.
   3. Requirements for key control system.

H. Pre-Installation Conference: Conduct conference at Project site. Review methods and procedures related to electrified door hardware including, but not limited to, the following:
   1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
   2. Review sequence of operation for each type of electrified door hardware.
   3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

I. Reference Standards: Except as otherwise required by governing authorities or Contract Documents, comply with applicable provisions of Door and Hardware Institute.

1.6 PRODUCT DELIVERY

A. Deliver door hardware to the Contractor. Direct factory shipments (drop shipments) to the job site are not acceptable.
   1. Deliver items of hardware at the proper times to the proper locations (shop or project site) in their original individual containers, complete with necessary appurtenances including screws, keys, manufacturers' printed instructions, and where necessary, installation templates for manufacturer's suggested installation. Mark each individual container with the manufacturer's name and catalog number as they appear in the hardware schedule.

B. Keys:
   1. Supply construction master keys to Contractor when cylinders are delivered, for use during construction.
   2. Prior to the scheduled completion of the project, manufacturer shall ship all permanent keys, including grand master keys, master keys, change keys and blank keys directly to Owner via registered mail or other pre-approved means. Under no circumstance shall any permanent keys be furnished direct to the Contractor.
      a. Submit documentation of keying compliance including copies of signed transmittals, for all building keys provided.

C. Key Cabinet: Deliver key cabinet to the Owner prior to building occupancy.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking, or breakage.
      b. Faulty operation of operators and door hardware.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
   2. Warranty Period: Two years from date of Substantial Completion, except as follows:
      a. Manual Closers and Continuous Hinges: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 “Hardware Set Schedule” Article.
   1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products or products equivalent in function and comparable in quality to named products where other manufacturers are permitted.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 “Hardware Set Schedule” Article. Products are identified by using door hardware designations, as follows:
   1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements.
   2. Manufacturers name or logo shall not be visible on any finished surface exposed to “public” view.

2.2 HARDWARE ITEMS

A. Hinges: Bommer Industries, Hager Companies, McKinney or Stanley Works.
   1. Furnish two hinges for doors 60-inches or less in height and one additional hinge for each additional 30-inches of height or fraction thereof. Unless otherwise specified, hinges for doors through 36-inches wide shall be 4.5" x 4.5"; hinges for doors over 36-inches wide shall be heavy-weight 5" x 4.5". Hinges for labeled doors shall comply with the requirements of NFPA 80.
   2. Furnish non-removable pins (NRP) for all reverse bevel doors receiving keyed locks, rigid outside trim or exit only hardware. Provide hinges with holes in the bottom plug to facilitate pin removal.
   3. Hinges with anti-friction bearings may be furnished in lieu of ball bearing hinges; except where prohibited on fire doors by the requirements of NFPA 80.

B. Continuous Hinges: Hager Companies (Roton) or Select Products, Inc.
   1. Geared-Type: Extruded aluminum with nylon bearings.

C. Cylinders: Sargent Manufacturing Company.
   1. Cylinders shall have a minimum of six pins.
   2. All cylinders shall be construction master keyed. Equip locks with manufacturer's special pin tumbler cylinders that permit voiding construction keys without removal of the cylinder.
   3. Provide cylinders complete with collars, tailpieces and cams as required.

D. Locks and Latches: Best Access Systems, Corbin Russwin Architectural Hardware, Sargent Manufacturing Company, Schlage Lock Company or Yale Security, Inc.
   1. Levers shall be cast or solid metal. All internal working parts shall be brass, bronze, steel or stainless steel.
      a. For each lock and latchset, provide wrought metal strike box (equal to Sargent Part No. 77-1141) and square corner ASA strike with curved lips of sufficient length to protect frames.
      b. Furnish knurling to lever on corridor side of door to all doors leading to hazardous areas (e.g. Mechanical Rooms, Electrical Rooms, Elevator Machine Rooms, etc.).
   2. Locks and latches shall be equal to Sargent 8200 Series with LNP trim.
   3. Electrical Modifications:
      a. Locksets specified to be electrified shall be factory modified to electrically lock or electrically unlock, as indicated, upon receipt of a 24V signal and will remain in this mode until signal is interrupted.
      b. Locks indicated to have "Request-To-Exit" switches shall incorporate internal SPDT contacts for remote signaling of operation of the inside lever handle. Switches shall be used in conjunction with the Electronic Security Control System to accommodate "authorized egress".
      c. Field-connect electrified locksets to associated power transfer units. Coordinate electrical connection and installation with Divisions 26 and 28.

E. Exit Devices and Exit Device Accessories: Von Duprin, Inc.
   1. Refer to the Hardware Set Schedule for function. Where lever handle functions are required on exit devices, they shall match the design and construction of lever handles specified for other locks and latches.
      a. At mortise exit devices, provide wrought metal strike box and square corner, stainless steel ASA strike with curved lips of sufficient length to protect frames.
   2. All exit devices shall be through-bolt mounted in compliance with door manufacturers' requirements.
   3. Furnish keyed devices less cylinders; provide cylinders keyed to building system.
   4. Provide UL-labeled fire-exit hardware at fire-rated openings.
   5. Electrical Modifications:
      a. Exit devices specified to be electrified shall be factory modified to electrically lock or electrically unlock, as indicated, upon receipt of a 24V signal and will remain in this mode until signal is interrupted.
      b. Exit devices indicated to have electric latch retraction shall be modified to electrically

unlatch (dog down) upon receipt of a 24V signal and will remain unlatched until signal is interrupted.

c. Exit devices indicated to have "Request-To-Exit" switches shall incorporate internal SPDT contacts for remote signaling of operation of the push pad. Switches shall be used in conjunction with the Electronic Security Control System to accommodate "authorized egress".

d. Field-connect electrified exit devices to associated power transfer units. Coordinate electrical connection and installation with Divisions 26 and 28.

F. Door Closers: LCN Closers, Inc.

1. Surface closers shall be LCN 4041 Series; overhead concealed closers shall be LCN 6030 Series.
2. Closer arms shall be forged and fluid shall accommodate all applicable weather conditions.
   a. At parallel arm installations, provide manufacturer's heaviest-duty arm assembly.
3. Where factory sized closers are specified, sizes are to be determined by manufacturer's recommendations for door size, location and applicable handicap requirements.
4. All surface closers and closer-holders shall be through-bolt mounted in compliance with door manufacturers' requirements.
5. Locate surface closers on the least conspicuous side of the door (side opposite public view).
6. Electric Hold-Open Closers: Connect devices to fire or smoke/heat alarm system via dry contacts, so that when alarm devices are activated, or there is power loss in building, holders will release and doors will automatically close.
   a. Coordinate electrical connection and installation with Divisions 26 and 28.

G. Power-Assist Operators: LCN Closers, Inc.

1. Operators shall be of heavy-duty construction. Sizes are to be determined by manufacturer's recommendations for door size and location.
2. Operation:
   a. Pressing actuator switch automatically opens door leaf to 90-degrees, operator then manually closes door after variable time delay expires.
   b. Provide wall- and jamb- mounted stainless steel actuator plates as indicated. Actuators shall operate on voltage supplied by the operator.
      1) Engrave Universal Accessibility Symbol on plate; fill with blue enamel paint.
3. Control Unit:
   a. Micro-processor controlled.
   b. Provide adjustable opening speed, adjustable backcheck speed, adjustable closing speed, and adjustable hold-open period.
   c. Provide built-in 3-position switch for "OFF", "ON" and "HOLD-OPEN" operation and to deactivate exterior actuator switch.
   d. Provide safety-stop feature: If object or obstruction is encountered during opening and/or closing cycles, door operator stops and slowly returns to closed or open position respectively.
   e. Provide with safety circuit so that if actuator switch is activated when door is latched or locked, power operator resets without operator and/or door damage.
4. Manufacturer shall provide detailed wiring diagrams showing point-to-point hook-up of all components affected (e.g. actuators, operators, power, etc.).
5. Accessories: Furnish complete with fastenings, fittings, and other accessories as required for a complete installation.
   a. All operators shall be through-bolt mounted in compliance with door manufacturers' requirements.
6. Coordinate installation and electrical connection with Division 26.

H. Architectural Door Trim: Builders Brass Works, Hager Companies, Rockwood or Trimco.

1. Kick and armor plates shall be beveled on all sides, equal to Hager 194S.
   a. Except where otherwise indicated or where narrow bottom rails dictate a smaller size, kick plates shall be 10-inches high and armor plates 34-inches high. Width shall be 1.5-inches less than the door width on single doors and 1-inch less than the door width on double

doors.

b. Armor plates on labeled doors shall comply with the requirements of NFPA 80.

2. Furnish all flat goods with Phillips undercut, countersunk screws per ANSI A156.6. Trusshead screws are not acceptable.

3. Push and Pull Plates:

a. Plates shall be beveled on all sides, fabricated from 1/8-inch thick stainless steel.

1) Push plates shall be 6-inches wide and 16-inches high.

2) Pull plates shall be 4-inches wide and 16-inches high.

b. Pulls: Provide a minimum 2-1/4-inches clearance. Pulls shall be 10-inches center-to-center, mounted back-to-back with concealed fasteners.

1) Fabricate pulls from 1-inch round solid bar stock.

4. Push and Pull Bars:

a. Fabricate push and pull bars from 1-inch diameter solid stainless steel bar stock. Provide units complete with spacers threaded to accept concealed through bolt attachment including provision for spanner tightening of bolts and assembly. Do not furnish grommets at stile/pull interface.

b. Refer to the Hardware Set Schedule for style and design.

I. Auxiliary Hardware: Hager Companies, Ives, Rockwood or Trimco.

1. Stops: Furnish wall stops equal to Rockwood 403 wherever door strikes wall. Where wall stops are not suitable, furnish floor stops equal to Rockwood 441CU (with removable riser).

2. Manual Flush Bolts: Top manual flush bolts shall not exceed 74-inches from floor to centerline.

3. Silencers: Provide rubber silencers equal to Rockwood 608 for hollow metal frames and Rockwood 609 for wood frames.

a. Furnish three per single door and four per pair.

b. Silencers are not required at aluminum frames or at doors specified to receive continuous seals or weather-stripping.

J. Automatic Flush Bolts and Coordinators: Door Controls International, Hager Companies, Ives or Rockwood.

1. Coordinators shall be continuous across door header, complete with filler plates and closer brackets as required. Furnish coordinators primed for field painting.

a. Provide standard strikes with wrought boxes for top bolts.

K. Overhead Holders and Stops: Architectural Builders Hardware, Glynn-Johnson or Rixson.

1. Where wall or floor stops will not work, furnish concealed overhead stops equal to Glynn-Johnson 410S.

L. Thresholds, Weather-stripping and Seals: Hager Companies, National Guard Products, Pemko, Reese Enterprises or Zero International.

1. Refer to the Hardware Set Schedule for grade and style.

2. Smoke Seals: At all fire-rated wood doors and at all other doors required to be 'smoke resistant', provide the following:

a. Head and Jambs: Smoke seals equal to Pemko S88BL.

b. Meeting Stile at Pairs: Overlapping astragal seals equal to one Pemko 375CR or two Pemko 316AS as appropriate for intended hardware operation.

c. Refer to the Drawings for locations.

3. Where required, field-modify thresholds to receive strikes for exit devices and flush bolts.

M. Key Control System: Lund Equipment, MMF Key Control Products or Telkee.

1. Wall-mounted metal cabinet with baked-enamel finish; containing key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150% of the number of cylinders required herein.

a. Equip cabinet with hinged-panel door, key-holding panels, and pin-tumbler cylinder door lock.

b. Cross-Index System: Multiple-index system for recording key information. Include three

receipt forms for each key-holding hook.

N. Electromagnetic Holders: Architectural Builders Hardware, LCN Closers or Rixson.
1. Connect devices to fire or smoke/heat alarm system via dry contacts, so that when alarm devices are activated, or there is power loss in building, electromagnetic holders will automatically release allowing doors to close.
2. Coordinate electrical connection and installation with Divisions 26 and 28.

O. Electric Strikes: Folger Adam or Von Duprin.
1. Electric strikes shall be cast iron construction of function indicated.
2. Coordinate electrical connection and installation with Division 26.

P. Delayed Egress Locks: Von Duprin, Inc.
1. Description: Self-contained, delayed egress system with key bypass and audible alarm; allowing delayed exiting after pushing on door.
2. Operation:
   a. Applying 15-pounds or less pressure to device sends remote signal to security system, triggers unlocking sequence and sounds audible alarm.
   b. Fifteen seconds after pushing on device, system releases to allow exiting. System can be activated and de-activated by built-in key switch.
   c. When delayed egress system is activated, delayed egress lock shall automatically disable alarm and unlock upon receipt of valid signal from access control system.
   d. When delayed egress system is activated, delayed egress lock shall automatically unlock upon activation of fire and heat/smoke alarm system. Coordinate with installation and operation of fire and heat/smoke alarm system.
   e. When delayed-egress locks are installed on adjacent door leaves (e.g. pairs or banks of doors), devices shall be wired in sequence so that activation of one lock causes all devices in row to unlock.
   f. Provide fail-safe application so that system unlocks in event of power failure.
3. Signage: Furnish with satin stainless steel sign mounted on door, engraved with block capital letters 1-inch in height that read “PUSH UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 SECONDS.” Fabricator shall fill lettering with black enamel paint
   a. Sign shall be located above and within 12-inches of the exit/actuation device.
   b. Attach sign to door with Phillips undercut, countersunk screws.
4. Coordinate electrical connection and installation with Divisions 26 and 28.

Q. Power Transfer Pivots: Architectural Builders Hardware, Securitron or Von Duprin.
1. Concealed PTFE-jacketed wires, secured at each leaf and continuous through sleeve.

R. Magnetic Door Contacts: Magnetic door contacts are furnished by the Security Sub-contractor. Furnish templates for products indicated so doors and frames are properly factory-machined to receive material without field-modification.

S. Special Tools: Provide any necessary special tools (e.g. spanner and socket wrenches, dogging keys, etc.) required to service and adjust hardware items.

2.3 FINISHES

A. Base metals: Produce hardware units of basic metal and forming method indicated, using manufacturers standard metal alloy composition, temper and hardness, but in no case of lesser quality than specified or inferred by use of a particular manufacturer's number, style or grade or as established by appropriate referenced specification listed herein.

B. Finishes: Finishes shall conform to the quality of finish including thickness of plating or coating (if any),

composition, hardness and other qualities complying with manufacturer's standards, but in no case less than the standards established by ANSI/BHMA A156.18 or Federal Specifications FF-H-111C as applicable.

1. All exposed hardware shall be satin chrome plated, ANSI/BHMA 626/US26D.
    a. Surface closers shall be powder coated to match satin chrome.
    b. Butt hinges on exterior doors shall be satin stainless steel, ANSI/BHMA 630/US32D.
    c. Push-pulls and flat goods shall be satin stainless steel, ANSI/BHMA 630/US32D.
    d. Continuous geared hinges shall be powder coated to match storefront, coordinate with Division 08 Section "Aluminum Monumental Stile and Rail Doors" for color.
2. Where painting of primed surfaces is required, refer to Division 09 specifications.

2.4 KEYS AND KEYING

A. Keying: Provide the type of system required (e.g. master, grand master, great grand master). Nomenclature and layout shall be consistent with DHI "Keying Systems and Terminology".
1. All cylinders shall operate on the existing Montgomery College/Germantown Campus Masterkey System utilizing the Sargent "RL" Keyway.

B. Keys: Provide keys of nickel silver only in the following quantities:
1. Three change keys per cylinder.
2. Five master keys (per set).
3. Three grand master keys (as required).
4. Thirty key blanks.
5. Fifteen construction master keys (for use during construction).

C. Identification:
1. Stamp change keys with the key change number.
2. Stamp change keys with the key change number; stamp all master keys and grand master keys "DO NOT DUPLICATE".

2.5 FASTENERS

A. Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping or sheet metal screws except as specifically indicated.
1. Furnish screws for installation with each hardware item. Provide Phillips flat head or oval head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces of other work, to match the finish of such work as closely as possible, except as otherwise indicated.
    a. Where wood screws are required they shall be full thread (to the head) type. Combination wood/machine screws, in lieu of wood screws, are not acceptable.
2. Provide concealed fasteners for hardware units which are exposed when the door is closed, except to the extent no standard manufactured units of the type specified are available with concealed fasteners. Do not use through bolts for installation except where it is not possible to adequately reinforce the work, to accept machine screws or concealed fasteners or another standard type, to satisfactory avoid the use of through bolts. Grommet nuts and cealnuts are not acceptable.

3. Furnish fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of hardware, base material reinforcement or fastener. Furnish wall stops with "Toggler" anchors and wood screws. Furnish thresholds and floor stops with lead anchors and 1/4-20 stainless steel machine screws.

PART 3 - EXECUTION

3.1 STORAGE AND HANDLING

A. Representatives of the Contractor and the Hardware Supplier shall jointly inventory the door hardware. Replace items damaged in shipment promptly and with proper material without additional cost to the Contractor. Handle all hardware in a manner to eliminate marring, scratching or damage.
   1. A dry, locked storage space complete with adequate shelving shall be set aside for the purpose of unpacking, sorting out, checking and storage. Control the handling and installation of hardware items, whether immediately replaceable or not, so completion of the work will not be delayed by losses before or after installation.
   2. Tag each item or package separately, with identification related to the final approved hardware schedule, and include basic installation instructions in the package. Furnish hardware items of proper design for use on doors and frames of thickness, profile, swing, security and similar requirements indicated as necessary for proper installation and function.

3.2 COORDINATION

A. Coordinate Door Hardware Schedule submission and hardware ordering to insure delivery of all items as directed by the Contractor.
   1. Prior to ordering any hardware, examine the shop drawings and details of doors and frames and other substrate suppliers to determine that the proper type and size pieces of hardware are being furnished. No extra for material or labor will be allowed for any corrections that should have been eliminated by proper prior coordination.

B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, and access control system.

D. Coordination with Adjacent Finishes:
   1. If cutting and fitting are required to install hardware onto or into surfaces that are later painted or finished in another way, install each item completely and then remove and store in secure place during finish application.
   2. After completion of finishes, reinstall each item.
   3. Do not install surface mounted items until finishes are complete on substrate.

3.3 INSTALLATION

A. Install each hardware item in accordance with final approved Hardware Schedule and manufacturer's instructions.
   1. Set hardware level, plumb and true to line and location.
   2. Adjust and reinforce attachment substrate as required for proper installation and operation of hardware.

3. Drill and countersink units which are not factory-prepared for anchorage fasteners; space fasteners and anchors uniformly, in accordance with industry standards.

B. Hardware Mounting Heights:
1. Provide heights as indicated on Drawings, except as otherwise required for compliance with governing regulations.
2. Where heights are not indicated, comply with mounting requirements of DHI "Recommended Locations for Builder's Hardware" on custom steel doors and frames.

C. Hinges:
1. Install steel doors and wood doors to comply with reference standards, as specified in door sections.
2. Where shimming is required to comply with tolerances, provide metal shims only.

D. Closers:
1. Do not install parallel arm closers until after weather-stripping or seals have been installed on head frame (where weather-stripping or seals are scheduled).
2. Do not cut weather-stripping or seals for attachment of closer brackets or shoes.
3. Adjust closers to control door swing and to provide positive latching of doors.
   a. Adjust closers not to exceed following manual opening forces:
      1) Exterior doors: As required to close and latch each leaf.
      2) Interior doors (non-fire-rated): Maximum 5-pound opening force.
      3) Fire-rated doors: As required to close and latch each leaf.
   b. After air-handling system has been balanced, make final adjustment of all closers.

E. Door Stops:
1. Install stops for maximum degree of door opening swing allowed by conditions of installation.
2. Locate floor stops so as not to create a tripping hazard.
3. Locate wall stops centered on spindle of lever handles.

F. Weather-stripping and Seals:
1. Install continuous around door heads and jambs, and meeting stiles of pairs of doors.
2. Install bottom weather-stripping and automatic door bottoms for full width of door.
3. Do not cut weather-stripping or seals for attachment of closer brackets or shoes.
4. Align rain drips with the bottom edge of the door frame rabbet, set in a bed of sealant, and attach with stainless steel fasteners.

G. Key Cabinet: Deliver key cabinet to the Owner prior to building occupancy and install where directed. Instruct the Owner in the use of the key control system.

H. Fire Doors and Exit Doors: Hardware for labeled fire doors shall be installed in accordance with the requirements of NFPA 80. Hardware for listed exit doors shall be installed in accordance with the requirements of NFPA 101.

3.4 ADJUST AND CLEAN

A. General: To insure proper operation and function of every unit, adjust and check each operating item of hardware and each door. Lubricate moving parts with type lubrication recommended by the manufacturer (graphite-type if no other recommended). Replace unit that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made.
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Verify that the Owner has been supplied with manufacturers' installation and maintenance manuals, catalogs, and any special adjusting tools normally supplied by the manufacturer.

B. Final Adjustment: When hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and perform a final check and adjustment of all hardware items in such space or area. Clean and re-lubricate as necessary to restore proper function and finish of hardware and doors.
   1. Prior to acceptance of any electrical hardware system, an operational test shall be performed to determine if devices are functioning as intended by the specifications. Wiring shall be tested for correct voltage, current-carrying capacity, and proper grounding. Stray voltages in lock wiring shall be eliminated to prevent locking devices from releasing in critical situations.

C. Six-Month Adjustment: Approximately six months after date of Substantial Completion, Installer shall perform the following:
   1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
   2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
   3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.5 HARDWARE SET SCHEDULE

Set 110

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Latchset 8215	Sargent
1	Stop	Rockwood

Set 111

	Hinges BB1191	Hager
1	Latchset 8215	Sargent
1	Surface closer P4041-H-CUSH	LCN
1 set	Weather-stripping 332CR - Head & Jambs	Pemko
1	Threshold 105A / 3673A / 68A x 31A	Zero
1	Sill sweep 315CN	Pemko
1	Rain drip 346C	Pemko
1	Magnetic door contact (prep only for Sentrol #1078)	

Set 114

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Latchset 8215	Sargent
1	Surface closer 4041-H-DEL (omit hold-open at Door #244E.1)	LCN
1	Kick plate 194S	Hager
1	Stop	Rockwood

Set 115

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Latchset 8215	Sargent
1	Surface closer P4041-DEL-H-CUSH	LCN
1	Kick plate 194S	Hager

Set 116

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Latchset 8215	Sargent
1	Surface closer 4041-DEL / P4041-DEL-EDA	LCN
1	Kick plate 194S	Hager
1	Stop	Rockwood

Set 213

1 set	Center pivots 7255	Ives
1	Lockset 4874 x 34-inches AFF	Sargent
2	Push plates 80S	Hager
1	Concealed closer 6031	LCN
2	Kick plates 194S	Hager
2	Stops	Rockwood

Set 220

	Hinges BB1279	Hager
2	Push plates 80S	Hager
2	Pull plates H84J-FB (TB pulls and conceal fasteners under push plates)	Hager
2	Surface closers P4041-EDA	LCN
2	Electromagnetic holders SEM 7850	LCN

Set 310

	Hinges BB1168	Hager
1	Exit device 98L-F x 996L-BE	Von Duprin
1	Surface closer 4041	LCN
1	Kick plate 194S	Hager
1	Stop	Rockwood

Set 313

	Hinges BB1168	Hager
1	Electrified exit device RX-98L-F x E996L - FAIL SECURE	Von Duprin
1	Cylinder - as required	Sargent
1	Power-assist operator 4630	LCN
1	Kick plate 194S	Hager
2	Wall-mounted actuators 8310-856T	LCN
1	Electric strike 6111 - FAIL SECURE (interface with power operator)	Von Duprin
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Function: Card reader on unsecure-side of door will shunt door contact, release electrified trim, and enable wall-mounted actuator; pressing actuator releases electric strike and activates door operator. Wall-mounted actuator on secure-side of door will shunt door contact, release electric strike, and activate door operator. Depressing crash bar will shunt door contact and allow authorized egress.

Set 315

	Hinges BB1279	Hager
1	Electrified exit device RX-98L x E996L - FAIL SECURE	Von Duprin
1	Cylinder - as required	Sargent
1	Surface closer P4041-EDA	LCN
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 319

	Hinges BB1191	Hager
1	Electrified exit device RX-98L x E996L - FAIL SECURE	Von Duprin
1	Cylinder - as required	Sargent
1	Surface closer P4041-CUSH	LCN
1 set	Weather-stripping 332CR - Head & Jambs	Pemko
1	Threshold 2005AT	Pemko
1	Sill sweep 315CN	Pemko
1	Rain drip 346C	Pemko
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	

Set 320

	Hinges BB1168	Hager
2	Exit devices 9827EO-F-LBR	Von Duprin
2	Surface closers P4041-EDA	LCN
2	Kick plates 194S	Hager
2	Electromagnetic holders SEM 7850	LCN

Set 321

	Hinges BB1168	Hager
1	Delayed egress lock CX-9827EO-F-LBR - FAIL SAFE (west leaf)	Von Duprin
1	Electrified exit device RX-9827EO-F-LBR (east leaf)	Von Duprin
2	Surface closers P4041-EDA	LCN
2	Kick plates 194S	Hager
2	Power transfer pivots EPT-10 (EPT-2 at east leaf)	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
1	Power supply PS-873FA	Von Duprin
1	Delayed-egress sign 670 (see 08710, 2.2P.3)	Rockwood
2	Electromagnetic holders SEM 7850	LCN

Set 322

	Hinges BB1279	Hager
2	Exit devices 9847L-F-LBR x 996L-BE	Von Duprin
2	Electric hold-open closers P4041-SE	LCN
2	Kick plates 194S	Hager
2	Stops	Rockwood

Set 323

	Hinges BB1168	Hager
2	Electrified exit devices RX-98L x E996L - FAIL SECURE	Von Duprin
1	Removable mullion KR4954 x 154 (field-paint to match frame finish)	Von Duprin
3	Cylinders – as required	Sargent
2	Surface closers P4041-EDA	LCN
2	Kick plates 194S	Hager
2	Power transfer pivots EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
2	Stops	Rockwood

Set 324

	Hinges BB1168	Hager
2	Exit devices 98L-F x 996L-BE	Von Duprin
1	Removable mullion KR9954 x 154 (field-paint to match frame finish)	Von Duprin
1	Cylinder – as required	Sargent
2	Surface closers T4041 x 180-degrees (P4041-EDA at Door #0SD.1)	LCN
2	Kick plates 194S	Hager
2	Stops	Rockwood

Set 325

	Hinges BB1168	Hager
2	Electrified exit devices RX-98L x E996L - FAIL SECURE	Von Duprin
1	Removable mullion KR4954 x 154 (field-paint to match frame finish)	Von Duprin
3	Cylinders – as required	Sargent
2	Surface closers P4041-H-EDA	LCN
2	Kick plates 194S	Hager
2	Power transfer pivots EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
2	Stops	Rockwood

Set 326

	Hinges BB1168	Hager
2	Electrified exit devices RX-9847L-F-LBR x E996L - FAIL SECURE	Von Duprin
2	Cylinders – as required	Sargent
2	Electric hold-open closers P4041-SE	LCN
2	Kick plates 194S	Hager
2	Power transfer pivots EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
2	Stops	Rockwood

Set 327

	Hinges BB1279	Hager
2	Electrified exit devices RX-98L x E996L - FAIL SECURE	Von Duprin
1	Removable mullion KR4954 x 154 (field-paint to match frame finish)	Von Duprin
3	Cylinders – as required	Sargent
2	Surface closers P4041-EDA	LCN
2	Kick plates 194S	Hager
2	Power transfer pivots EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
2	Stops	Rockwood

Set 402

	Cylinders – as required	Sargent
2	Magnetic door contacts (prep for Sentrol #2204AU)	
	Balance of hardware by door manufacturer	

Set 403

1	Cylinder – as required	Sargent
2	Kick plates 194S	Hager
2	Stops	Rockwood
	Balance of hardware by fire rated door assembly manufacturer	

Set 420

2	Continuous hinges 780-112HD (factory-finish to match storefront)	Hager
2	Push pads 350	Von Duprin
2	Pulls 976P (30-inches) x TB fasteners with finished caps	Hager
2	Surface closers P4041-CUSH x 4040-18PA	LCN
1 set	Weather-stripping – Head, Jambs & Meeting Stile	Door Manufacturer

Set 422

2	Continuous hinges 780-112HD (factory-finish to match storefront)	Hager
2	Push pads 350	Von Duprin
2	Pulls 976P (30-inches) x TB fasteners with finished caps	Hager
1	Surface closer P4041-CUSH x 4040-18PA	LCN
1	Power-assist operator 4630	LCN
1	Wall-mounted actuator 8310-856T (pull-side)	LCN
1	Jamb actuator 8310-818T (push-side)	LCN
1 set	Weather-stripping – Head, Jambs & Meeting Stile	Door Manufacturer
1	Floor stop 466 (power-assist leaf)	Rockwood

Set 424

2	Continuous hinges 780-112HD (factory-finish to match storefront)	Hager
2	Push pads 350	Von Duprin
2	Pulls 976P (30-inches) x TB fasteners with finished caps	Hager
1	Surface closer P4041-CUSH x 4040-18PA	LCN
1	Power-assist operator 4630	LCN
2	Jamb actuators 8310-818T (locate pull-side actuator in adjacent mullion)	LCN
1 set	Weather-stripping – Head, Jambs & Meeting Stile	Door Manufacturer
1	Floor stop 466 (power-assist leaf)	Rockwood

Set 431

1	Continuous hinge 780-112HD x CPT (factory-finish to match storefront)	Hager
1	Electrified exit device RX-EL-35A-NL-OP	Von Duprin
1	Cylinder – as required	Sargent
1	Pull 976P (30-inches) x TB fasteners with finished caps	Hager
1	Surface closer P4041-CUSH x 4040-18PA	LCN
1 set	Weather-stripping – Head & Jambs	Door Manufacturer
1	Threshold 2005AT	Pemko
1	Sill sweep 315CN (grey inserts)	Pemko
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	

Set 440

2	Continuous hinges 780-112HD x CPT (factory-finish to match storefront)	Hager
2	Electrified exit devices RX-EL-35A-EO	Von Duprin
1	Removable mullion KR4954 x 154 (field-paint to match frame finish)	Von Duprin
1	Cylinder – as required	Sargent
2	Pulls 976P (30-inches) x TB fasteners with finished caps	Hager
2	Surface closers P4041-CUSH x 4040-18PA	LCN
1 set	Weather-stripping – Head, Jambs & Meeting Stile	Door Manufacturer
1	Threshold 2005AT	Pemko
2	Sill sweeps 315CN (grey inserts)	Pemko
1	Power supply PS873-2	Von Duprin
2	Power transfer pivots EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	

Set 441

2	Continuous hinges 780-112HD x CPT (factory-finish to match storefront)	Hager
1	Electrified exit device RX-EL-35A-NL-OP	Von Duprin
1	Electrified exit device RX-EL-35A-EO	Von Duprin
1	Removable mullion KR4954 x 154 (field-paint to match frame finish)	Von Duprin
2	Cylinders – as required	Sargent
2	Pulls 976P (30-inches) x TB fasteners with finished caps	Hager
2	Surface closers P4041-CUSH x 4040-18PA	LCN
1 set	Weather-stripping – Head, Jambs & Meeting Stile	Door Manufacturer
1	Threshold 2005AT	Pemko
2	Sill sweeps 315CN (grey inserts)	Pemko
1	Power supply PS873-2	Von Duprin
2	Power transfer pivots EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	

Set 442

2	Continuous hinges 780-112HD x CPT (factory-finish to match storefront)	Hager
1	Electrified exit device RX-EL-35A-NL-OP	Von Duprin
1	Electrified exit device RX-EL-35A-EO	Von Duprin
1	Removable mullion KR4954 x 154 (field-paint to match frame finish)	Von Duprin
2	Cylinders – as required	Sargent
2	Pulls 976P (30-inches) x TB fasteners with finished caps	Hager
1	Surface closer P4041-CUSH x 4040-18PA	LCN
1	Power-assist operator 4640	LCN
1	Wall-mounted actuator 8310-856T (pull-side)	LCN
1	Jamb actuator 8310-818T (push-side)	LCN
1 set	Weather-stripping – Head, Jambs & Meeting Stile	Door Manufacturer
1	Threshold 2005AT	Pemko
2	Sill sweeps 315CN (grey inserts)	Pemko
1	Power supply PS873-2	Von Duprin
2	Power transfer pivots EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
1	Floor stop 466 (power-assist leaf)	Rockwood

Function: Card reader on exterior-side of door will shunt door contacts, retract electric latches, and enable wall-mounted actuator; pressing actuator activates door operator. Jamb-mounted actuator on interior-side of door will shunt door contacts, retract electric latches, and activate door operator. Depressing crash bars will shunt door contacts and allow authorized egress. When door is locked / latched, wall-mounted actuator should not function.

Set 444

2	Continuous hinges 780-112HD x CPT (factory-finish to match storefront)	Hager
1	Electrified exit device RX-EL-35A-NL-OP	Von Duprin
1	Electrified exit device RX-EL-35A-EO	Von Duprin
1	Removable mullion KR4954 x 154 (field-paint to match frame finish)	Von Duprin
2	Cylinders – as required	Sargent
2	Pulls 976P (30-inches) x TB fasteners with finished caps	Hager
1	Surface closer P4041-CUSH x 4040-18PA	LCN
1	Power-assist operator 4640	LCN
1	Wall-mounted actuator 8310-856T (pull-side)	LCN
1	Jamb actuator 8310-818T (push-side)	LCN
1	Bollard BPS IG-US32D (6" x 6"/Angled Top/54" tall)	WIKK
1 set	Weather-stripping – Head, Jambs & Meeting Stile	Door Manufacturer
1	Threshold 2005AT	Pemko
2	Sill sweeps 315CN (grey inserts)	Pemko
1	Power supply PS873-2	Von Duprin
2	Power transfer pivots EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
1	Floor stop 466 (power-assist leaf)	Rockwood

Function: Card reader on exterior-side of door will shunt door contacts, retract electric latches, and enable bollard-mounted actuator; pressing actuator activates door operator. Jamb-mounted actuator on interior-side of door will shunt door contacts, retract electric latches, and activate door operator. Depressing crash bars will shunt door contacts and allow authorized egress. When door is locked / latched, bollard-mounted actuator should not function.

Prepare bollard to receive additional security devices; coordinate with Division 28 and the Security System Integrator

Set 510

	Hinges BB1279	Hager
1	Lockset 8205	Sargent
1	Coat hook 3071	Trimco
1	Stop	Rockwood

Set 511

	Hinges BB1279	Hager
1	Lockset 8268	Sargent
1	Coat hook 3071	Trimco
1	Stop	Rockwood

Set 514

	Hinges BB1279	Hager
1	Electrified lockset RX-8271 – FAIL SECURE	Sargent
1	Surface closer 4041-H	LCN
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 515

	Hinges BB1279	Hager
1	Electrified lockset RX-8271 – FAIL SECURE	Sargent
1	Coat hook 3071	Trimco
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 611

	Hinges BB1191 (BB1199 at doors over 36-inches wide)	Hager
1	Lockset 8204 (free egress from roof)	Sargent
1	Surface closer P4041-H-CUSH	LCN
1 set	Weather-stripping 332CR - Head & Jambs	Pemko
1	Threshold 105A / 3673A / 68A x 31A	Zero
1	Sill sweep 315CN	Pemko
1	Rain drip 346C	Pemko
1	Magnetic door contact (prep only for Sentrol #1078)	

Set 621

	Hinges BB1191	Hager
1	Lockset 8204 (free egress from roof)	Sargent
2	Flush bolts 555	Rockwood
1	Dust strike 570	Rockwood
2	Surface closers P4041-H-CUSH	LCN
1 set	Weather-stripping 332CR - Head & Jambs	Pemko
1	Threshold 105A / 3673A / 68A x 31A	Zero
1	Meeting stile gasket 375CR	Pemko
2	Sill sweeps 315CN	Pemko
1	Rain drip 346C	Pemko
2	Magnetic door contacts (prep only for Sentrol #1078)	

Set 812

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1	Surface closer 4041-DEL / P4041-DEL-EDA	LCN
1	Kick plate 194S (armor plate at Door #156.1)	Hager
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 813

	Hinges BB1279	Hager
1	Electrified lockset RX-8270 - FAIL SAFE	Sargent
1	Surface closer 4041	LCN
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Power supply MPS10	Sargent
1	Stop	Rockwood
	Connect to Fire Alarm for “fail safe” operation	

Set 814

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1	Surface closer 4041 / P4041-EDA	LCN
1	Kick plate 194S	Hager
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 815

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1	Surface closer 4041 / P4041-EDA	LCN
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 816

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Electrified lockset RX-8271 – FAIL SECURE	Sargent
1	Surface closer 4041-H / P4041-H-EDA	LCN
1	Kick plate 194S	Hager
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 817

	Hinges BB1191	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1	Surface closer P4041-CUSH	LCN
1	Kick plate 194S	Hager
1 set	Weather-stripping 332CR – Head & Jambs	Pemko
1	Threshold 2005AT	Pemko
1	Sill sweep 315CN	Pemko
1	Rain drip 346C	Pemko
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	

Set 818

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1	Surface closer TJ4041 x 4040-18G	LCN
1 set	Seals 350CSPK – Head & Jambs	Pemko
1	Threshold 151A	Pemko
1	Automatic door bottom 4301CPKL / 420APKL	Pemko
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 819

	Hinges BB1191	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1	Surface closer P4041-H-CUSH	LCN
1 set	Weather-stripping 332CR - Head & Jambs	Pemko
1	Threshold 2005AT	Pemko
1	Sill sweep 315CN	Pemko
1	Rain drip 346C	Pemko
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	

Set 822

	Hinges BB1279	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
2	Flush bolts 555	Rockwood
1	Dust strike 570	Rockwood
1	Surface closer 4041-DEL / P4041-DEL-EDA	LCN
2	Kick plates 194S	Hager
1	Power transfer pivot EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
2	Stops	Rockwood
	Astragal by door manufacturer	

Set 823

	Hinges BB1168	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1 set	Automatic flush bolts 1848 / 1948	Rockwood
1	Coordinator 1600 x USP (field-paint to match frame finish)	Rockwood
2	Surface closers 4041-DEL / P4041-DEL-EDA	LCN
2	Kick plates 194S	Hager
1	Power transfer pivot EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
2	Stops	Rockwood
	Astragal by door manufacturer	

Set 824

	Hinges BB1279	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1 set	Automatic flush bolts 1848 / 1948	Rockwood
1	Coordinator 1600 x USP (field-paint to match frame finish)	Rockwood
2	Surface closers 4041 / P4041-EDA	LCN
2	Kick plates 194S	Hager
1	Power transfer pivot EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	
2	Stops	Rockwood
	Astragal by door manufacturer	

Set 825

	Hinges BB1279	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
2	Flush bolts 555	Rockwood
1	Dust strike 570	Rockwood
1	Surface closer 4041 / P4041-EDA	LCN
1	Power transfer pivot EPT-10	Von Duprin
2	Magnetic contacts (prep only for Sentrol #1078)	
2	Stops	Rockwood
	Astragal by door manufacturer	

Set 827

	Hinges BB1199	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
2	Flush bolts 555	Rockwood
1	Dust strike 570	Rockwood
2	Surface closers P4041-H-CUSH	LCN
2	Armor plates 194S	Hager
1 set	Weather-stripping 332CR – Head & Jambs	Pemko
1	Threshold 2005AT	Pemko
1	Meeting stile gasket 375CR	Pemko
2	Sill sweeps 315CN	Pemko
1	Rain drip 346C	Pemko
1	Power transfer pivot EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	

Set 828

	Hinges BB1191 (BB1199 at doors over 36-inches wide)	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
2	Flush bolts 555	Rockwood
1	Dust strike 570	Rockwood
2	Surface closers P4041-H-CUSH	LCN
1 set	Weather-stripping 332CR – Head & Jambs	Pemko
1	Threshold 2005AT	Pemko
1	Meeting stile gasket 375CR	Pemko
2	Sill sweeps 315CN	Pemko
1	Rain drip 346C	Pemko
1	Power transfer pivot EPT-10	Von Duprin
2	Magnetic door contacts (prep only for Sentrol #1078)	

Set 830

	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Electrified lockset RX-8271 - FAIL SECURE	Sargent
1	Surface closer P4041-DEL-CUSH	LCN
1	Kick plate 194S	Hager
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	

Set 831

	Hinges BB1279	Hager
1	Electrified lockset 8271 - FAIL SECURE	Sargent
1	Surface closer 4041 / P4041-EDA	LCN
1	Power transfer pivot EPT-2	Von Duprin
1	Magnetic door contact (prep only for Sentrol #1078)	
1	Stop	Rockwood

Set 832		
	Hinges BB1279 (BB1168 at doors over 36-inches wide)	Hager
1	Electrified lockset 8273 - FAIL SECURE	Sargent
1	Surface closer P4041-DEL-CUSH	LCN
1	Kick plate	Hager
1	Power transfer pivot EPT-10	Von Duprin
1	Magnetic contact (prep only for Sentrol #1078)	

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.
3. Glazed curtain walls.
4. Interior borrowed lites.
5. Accessories – applied translucent film.

B. Related Sections:

1. Division 05 Section "Decorative Metal Railings" for glass panels in railings.
2. Division 08 Section "Hollow Metal Doors and Frames" for light frame assemblies.
3. Division 08 Section "Flush Wood Doors" for light frame assemblies.
4. Division 08 Section "Aluminum Monumental Stile and Rail Doors" for glazing in exterior entrance doors.
5. Division 08 Section "Glazed Aluminum Curtain Walls" for glazing sealants.
6. Division 08 Section "Fire rated Glass" for fire-rated glazing materials installed as vision lights in fire-rated doors and as borrowed lites in fire-rated frames.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer, using the following design criteria:

1. Design Wind Pressures: As indicated on Drawings.
2. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.

   a. Wind Design Data: As indicated on Drawings.
3. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.5 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

C. Translucent Film:

1. Samples for Color Selection: Manufacturer's standard sample sets showing the full range of colors available for each type of product indicated.
2. Samples for Verification: 12-inch square samples of each glazing film, of each product color specified applied to glass type specified to receive translucent film.

D. Glazing Accessory Samples: For gaskets, in 12-inch lengths.

E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

F. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installers and manufacturers of insulating-glass units with sputter-coated, low-e coatings.

B. Product Certificates: For glass and glazing products, from manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for coated glass and glazing gaskets.

D. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Source Limitations for Glass: Obtain glass products from single source from single manufacturer for each glass type.

E. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

G. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

H. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.

I. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

J. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Install glazing in mockups specified in Section 084413 "Glazed Aluminum Curtain Walls"- to match glazing systems required for Project, including glazing methods.

K. Translucent Film Mockups: Apply glazing films in locations as directed to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
1. Obtain approval of field samples before continuing with remainder of installation.
2. Maintain field samples during remainder of installation in an undisturbed condition as a standard for judging the completed Work.
3. Approved field samples may become part of the completed Work.

L. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.

B. Strength: Where float glass is indicated, provide Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.

B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.

1. For uncoated glass, comply with requirements for Condition A.
2. For coated vision glass, comply with requirements for Condition C (other coated glass).

C. Ceramic-Coated Vision Glass: Heat-treated float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's Tempering Division's "Engineering Standards Manual" and with other requirements specified.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Viracon VE1-2M with low E coating and Viracon silkscreen on #2 surface or comparable product by one of the following:

a. Guardian Industries.
b. Oldcastle Glass.

2. Glass: Clear float, Kind HS.
3. Ceramic Coating Color and Pattern:

a. Line Series, pattern no. 2002, 1/8” lines- 1/8” space.
b. Color: White.

2.3 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172 and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with manufacturer's standard translucent interlayer to comply with interlayer manufacturer's written recommendations.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Saflex laminated glass by Solutia, Inc. with Vanceva interlayer or comparable product by one of the following:

1. Guardian Industries.
2. Oldcastle Glass.

C. Glass: ¼" Laminated glass consisting of two layers 3.0 mm float glass, Kind FT, with interlayer.

1. Interlayer: Vanceva color systems; Color 0009 - Arctic Snow.

2.4 INSULATING GLASS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Guardian Industries.
2. Oldcastle Glass.
3. Viracon, Inc.

B. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
2. Spacer: Aluminum with black, color anodic finish.
3. Desiccant: Molecular sieve or silica gel, or blend of both.

C. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.

2.5 FIRE-PROTECTION-RATED GLAZING

A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.

B. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
b. Schott North America, Inc.; Laminated Pyran Crystal.
c. Vetrotech Saint-Gobain; SGG Keralite FR-L.

2.6 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:

1. Neoprene complying with ASTM C 864.
2. EPDM complying with ASTM C 864.
3. Silicone complying with ASTM C 1115.
4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

2.7 GLAZING TAPES

A. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 APPLIED TRANSLUCENT FILM

A. Applied Translucent film: Single or multi-layered decorative film products, applied to interior glass surfaces, consisting of from outboard surface to inboard surface:

1. Removable release liner.
2. Pressure sensitive adhesive with integral ultraviolet absorbers.
3. Clear, dyed, or printed pattern layer of polyester film.
4. Scratch resistant coating.

B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. 3M; Fasara.
2. Solar-X; Solyx.
3. Solutia Inc.; LLumar Films

C. Fire Performance: Surface burning characteristics when tested in accordance ASTM E 84:

1. Flame Spread: 25, maximum.
2. Smoke Developed: 450, maximum.

D. Colors and Patterns: Selected from manufacturer's full range.

2.9 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.10 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

2.11 MONOLITHIC-GLASS TYPES

A. Glass Type A: Clear fully tempered float glass.

1. Thickness: 6.0 mm.
2. Provide safety glazing labeling.

B. Glass Type B: Laminated translucent glazing.

1. Thickness: 1/4 inch laminated glass.
2. Provide safety glazing labeling.

C. Glass Type C: Fire-protection-rated glazing.

1. 60-minute and 120-minute fire-rated glazing as indicated; laminated ceramic glazing.
2. Provide safety glazing labeling.

2.12 INSULATING-GLASS TYPES

A. Glass Type G1: Low-e-coated, clear insulating glass.

1. Overall Unit Thickness: 1 inch.
2. Thickness of Each Glass Lite: 6.0 mm.
3. Outdoor Lite: Heat-strengthened float glass.
4. Interspace Content: Argon.
5. Indoor Lite: Heat-strengthened float glass.
6. Low-E Coating: Sputtered on second surface.
7. Visible Light Transmittance: 70 percent minimum.
8. Winter Nighttime U-Factor: 0.25 maximum.
9. Summer Daytime U-Factor: 0.21 maximum.
10. Solar Heat Gain Coefficient: 0.37 maximum.

B. Glass Type G2: Low-e-coated, clear insulating fully tempered glass.

1. Overall Unit Thickness: 1 inch.
2. Thickness of Each Glass Lite: 6.0 mm.
3. Outdoor Lite: Fully tempered float glass.
4. Interspace Content: Argon.
5. Indoor Lite: Fully temoered float glass.
6. Low-E Coating: Sputtered on second surface.
7. Visible Light Transmittance: 70 percent minimum.
8. Winter Nighttime U-Factor: 0.25 maximum.
9. Summer Daytime U-Factor: 0.21 maximum.
10. Solar Heat Gain Coefficient: 0.37 maximum.
11. Provide safety glazing labeling.

C. Glass Type G3: Ceramic-coated, insulating vision glass.

1. Overall Unit Thickness: 1 inch.
2. Thickness of Each Glass Lite: 6.0 mm.
3. Outdoor Lite: Heat-strengthened float glass.
4. Interspace Content: Argon.
5. Indoor Lite: Heat-strengthened float glass.
6. Coating Location: Second surface.
7. Winter Nighttime U-Factor: 0.25 maximum.
8. Summer Daytime U-Factor: 0.21 maximum.
9. Solar Heat Gain Coefficient: 0.37 maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

C. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 TRANSLUCENT FILM

A. Examination:

1. Examine glass and surrounding adjacent surfaces for conditions affecting installation.
2. Report conditions that may adversely affect installation. In report, include description of any glass that is broken, chipped, cracked, abraded, or damaged in any way.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation:

1. Comply with manufacturer's written instructions for surface preparation.
2. Immediately before beginning installation of films, clean glass surfaces of substances that could impair glazing film's bond, including mold, mildew, oil, grease, dirt and other foreign materials.
3. Protect window frames and surrounding conditions from damage during installation.

C. Installation:

1. General: Comply with glazing film manufacturers' written installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
   a. Install film continuously, but not necessarily in one continuous length. Install with no gaps or overlaps.
   b. If seamed, install with no gaps or overlaps. Install seams vertical and plumb. No horizontal seams allowed.
   c. Do not remove release liner from film until just before each piece of film is cut and ready for installation.
   d. Install film with mounting solution and custom cut to the glass with neat, square comers and edges to within 1/8 inch of the window frame.
   e. Remove air bubbles, wrinkles, blisters, and other defects.
2. After installation, view film from a distance of 10 feet against a bright uniform sky or background. Film shall appear uniform in appearance with no visible streaks, banding, thin spots or pinholes.
   a. If installed film does not meet these criteria, remove and replace with new film.

D. Cleaning:

1. Remove excess mounting solution at finished seams, perimeter edges, and adjacent surfaces.
2. Use cleaning methods recommended by glazing film manufacturer.
3. Replace films that cannot be cleaned.

3.7 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 089000 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fixed, extruded-aluminum louvers.

B. Related Sections:

1. Section 074213 “Metal Wall Panels” for louver fins matching adjacent metal panel profile for wall louvers at penthouse.
2. Section 081113 "Hollow Metal Doors and Frames" for louvers set in hollow-metal door frames.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of metal finish required.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For color-finished louvers, use fasteners with heads that match color of louvers.

C. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.

1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.

F. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Wind-Driven-Rain-Resistant Louvers L-01, L-02, L-03, L-07, L-08, and L-09:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Airolite Company, LLC (The).
b. Greenheck Fan Corporation.
c. Nystrom, Inc.
d. Ruskin Company; Tomkins PLC.

2. Louver Depth: 6 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

B. Corrugated Panel Integrated Louvers L-04, L-05, and L-06: Wall louver integrated with metal wall panel profile.

1. Reference Section 074213 “Metal Wall Panels”.

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Insect screening.

B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Mill finish unless otherwise indicated.
3. Type: Rewirable frames with a driven spline or insert.

D. Louver Screening for Aluminum Louvers:

1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.5 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.6 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: Match Architect's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089000

SECTION 092116 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each component of gypsum board shaft wall assembly.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For shaft wall assemblies, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Fire-Resistance Rating: As indicated.

B. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.

1. Depth: As indicated.
2. Minimum Base-Metal Thickness: 0.033 inch.

C. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.

1. Minimum Base-Metal Thickness: Matching steel studs.

D. Firestop Tracks: Provide firestop track at head of shaft wall on each floor level.

E. Elevator Hoistway Entrances: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches, matching studs in depth, and not less than 0.033 inch thick.

F. Insulation: Sound attenuation blankets.

2.3 PANEL PRODUCTS

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.4 NON-LOAD-BEARING STEEL FRAMING

A. Steel Framing Members: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

1. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized unless otherwise indicated.

B. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Fire Trak Corp.; Fire Trak System.
b. Grace Construction Products; FlameSafe FlowTrak System.
c. Steel Network Inc. (The); VertiClip SLD Series.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.

1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.
2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 conducted by a qualified testing agency.

E. Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."

F. Acoustical Sealant: As specified in Section 092900 "Gypsum Board."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 078100 "Applied Fireproofing."

B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.

B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
2. Reinforcing: Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.

D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.

F. Firestop Tracks: Install to maintain continuity of fire-resistance-rated assembly indicated.

G. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.

H. Cant Panels: At projections into shaft exceeding 4 inches, install 1/2- or 5/8-inch- thick gypsum board cants covering tops of projections.

1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft wall framing.
2. Where steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft wall framing.

I. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.4 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092116.23

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized unless otherwise indicated.

B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.

1. Steel Studs and Runners:

a. Minimum Base-Metal Thickness: 0.027 inch.
b. Depth: As indicated on Drawings.

2. Dimpled Steel Studs and Runners:

a. Minimum Base-Metal Thickness: 0.025 inch.
b. Depth: As indicated on Drawings.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.

a. Type: Post-installed chemical anchor or Post-installed expansion anchor.

2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length required.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 0.027 inch.
b. Depth: As indicated on Drawings.

3. Dimpled Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 0.025 inch.
b. Depth: As indicated on Drawings.

4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base-Metal Thickness: 0.018 inch.

5. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.

   a. Configuration: Asymmetrical.

G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Armstrong World Industries, Inc.; Drywall Grid Systems.
   b. Chicago Metallic Corporation; Drywall Grid System.
   c. USG Corporation; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-

resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

a. Install two studs at each jamb unless otherwise indicated.
b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

2. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
3. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches (1219 mm) o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 24 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

   a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

   a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.

6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092613 - GYPSUM VENEER AND ACOUSTICAL PLASTERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Gypsum veneer acoustical plaster and primer.

B. Scope: Apply acoustic gypsum plaster to the following locations:
1. Gypsum Veneer Plaster: In Atrium Lobby 100 at all exposed gypsum board walls, ceilings and at vertical faces of soffits, excluding the high ceiling.
2. Acoustical Plaster: In Atrium Lobby 100 at the high ceiling.

C. Related Sections:

1. Division 09 Section "Non-Structural Metal Framing" for non-load-bearing steel framing.
2. Division 09 Section “Gypsum Board” for gypsum board panel substrates for gypsum veneer acoustical plaster.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Show manufacturer’s installation recommendations.

B. Samples: For the following products:

1. Textured Finishes: 12-inch by 12-inch samples of textured finish on rigid backing.

C. Product Test Reports:

1. ASTM C423 Mounting Type A for NRC.
2. ASTM E84 for Flame Spread.
3. ASTM E1477 for Light Reflectance.
4. ASTM D3960 for VOC.
5. ASTM D3273/ASTM D3274 for Mold.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Noise reductions Coefficient: NRC 0.30 as per ASTM C423–07a Test Mounting Type A.

B. Flame Spread shall be Class A with a flame spread and smoke development of less than 25 as per ASTM E84.

C. Light Reflectance shall be 0.79 as per ASTM E1477.

D. VOC content shall be zero as per ASTM D3960.

E. Meets ASTM D3273/ASTM D3274 Mold specification requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 843 requirements or gypsum veneer plaster manufacturer's written recommendations, whichever are more stringent.

B. Room Temperatures: Maintain not less than 55 deg F or more than 80 deg F for seven days before application of gypsum base and gypsum veneer plaster, continuously during application, and after application until veneer plaster is dry.

C. Avoid conditions that result in gypsum veneer plaster drying too rapidly.

1. Distribute heat evenly; prevent concentrated or uneven heat on veneer plaster.
2. Maintain relative humidity levels, for prevailing ambient temperature, that produce normal drying conditions.
3. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during veneer plaster application until it is dry.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain gypsum veneer acoustical plaster products, including gypsum base for veneer plaster, joint reinforcing tape, and embedding material, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. Low-Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 GYPSUM VENEER PLASTER

A. One-Component Gypsum Acoustical Veneer Plaster: ASTM C 587, ready-mixed, smooth, finish-coat veneer plaster formulated for application over separate base-coat material.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Fellert USA, Inc.; Ecoustic.
b. Pyrok, Inc.; Acoustement Plaster 20.
c. USG Corporation; Acoustical PlasterFinish.

B. Color: Integral custom color as selected by Architect.

C. Primer: Brush or roller applied primer as manufactured and recommended by the gypsum veneer acoustical plaster manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine wall and ceiling surfaces before installation. Reject panels that are wet, moisture damaged, or mold damaged. Assure substrate is free of oil, grease, dirt, paint, or other matter which would impair bond.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrate by filling voids and cracks and offsets; remove projections that result in telegraphing presence of imperfections.

1. Prime substrate with primer or bonding agent as recommended by the manufacturer.
2. Mask all adjoining surfaces in order to minimize damage from overspray.
3. Provide ventilation if required, and avoid excess drying rates.
4. Provide tarps or temporary enclosures as necessary to confine operations.

3.3 GYPSUM VENEER ACOUSTICAL PLASTERING

A. Bonding Agent: Apply bonding agent on dry substrate according to gypsum veneer plaster manufacturer's written recommendations.

B. Gypsum Veneer Plaster Mixing: Mechanically mix gypsum veneer plaster materials to comply with ASTM C 843 and with gypsum acoustical veneer plaster manufacturer's written recommendations.

C. Gypsum Veneer Acoustical Plaster Application: Apply in accordance with manufacturer's printed instructions using any rotary-stator plastering pump or other spray equipment approved by the manufacturer.

D. Install to thickness indicated or thickness required to achieve NRC specified.

E. Ensure that texture and color are all as per control sample.

3.4 CLEANING AND PATCHING

A. Remove overspray and fall out materials immediately upon completion of the work in each area. Clean surfaces to remove evidence of soiling

B. Repair or replace damaged work surfaces to acceptable conditions.

3.5 PROTECTION

A. Protect installed gypsum veneer acoustical plaster from damage from weather, condensation, construction, and other causes during remainder of the construction period.

B. Remove and replace gypsum veneer acoustical plaster and gypsum base panels that are wet, moisture damaged, or mold damaged.

END OF SECTION 092613

SECTION 092713 - GLASS-FIBER-REINFORCED GYPSUM (GFRG) FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes factory-molded, glass-fiber-reinforced gypsum fabrications for interior applications.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for steel framing, blocking, and bracing supporting glass-fiber-reinforced gypsum fabrications.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, weights, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For adhesives, documentation including printed statement of VOC content.

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and assembly of glass-fiber-reinforced gypsum fabrications.
3. Indicate requirements for joint treatment.

D. Samples: For each exposed product and for each color and texture specified.

1. Minimum size 6 inches square, representing actual product, color, and patterns.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup of each type of glass-fiber-reinforced gypsum fabrication.
2. Paint mockups to match final decoration scheduled or indicated and to comply with requirements specified in Section 099100 “Painting".
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C 1467/C 1467M. Transport, lift, and handle units with care, avoiding excessive stress and preventing damage; use appropriate equipment.

B. Store products in manufacturer's unopened packaging until ready for installation, in a clean dry area protected from weather, moisture and damage; store units upright and not stacked unless permitted by manufacturer.

1.6 FIELD CONDITIONS

A. Environmental Conditions:

1. Comply with ASTM C 1467/C 1467M.
2. Do not deliver or install glass-fiber-reinforced gypsum fabrications until building is enclosed, wet work is complete, and HVAC system is operating and continuously maintaining temperature and relative humidity at levels intended for building occupants.

B. Conditioning: Acclimatize glass-fiber-reinforced gypsum fabrications to ambient temperature and humidity of spaces in which they will be installed. Remove packaging and move units into installation spaces not less than 48 hours before installing them.

C. Field Measurements: Where glass-fiber-reinforced gypsum fabrications are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 GLASS-FIBER-REINFORCED GYPSUM FABRICATIONS

A. Fabrications: Molded, high density, glass-fiber-reinforced gypsum units complying with ASTM C 1381/C 1381M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Custom Castings Northeast, Inc.
   b. DEC Architectural Composites; Division of DEC Associates, Inc.
   c. First Class Building Products, Inc.
   d. Formglas Inc.
   e. Stromberg Architectural Products, Inc.

B. Embedments: Cold-rolled steel channels with ASTM 653/A 653M, G60 hot-dip galvanized coating.

C. Finish: Smooth for paint finish.

2.2 AUXILIARY MATERIALS

A. Adhesives: As recommended in glass-fiber-reinforced gypsum fabrication manufacturer's written instructions and as follows:

1. Adhesive shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Steel Drill Screws: Of sufficient length and size to securely fasten glass-fiber-reinforced gypsum fabrications to framing members, and as follows:

1. Screws complying with ASTM C 1002 for fastening glass-fiber-reinforced gypsum fabrications to steel members less than 0.033 inch thick.
2. Screws complying with ASTM C 954 for fastening glass-fiber-reinforced gypsum fabrications to steel members from 0.033 to 0.112 inch thick.

C. Joint-Treatment Materials: ASTM C 475/C 475M.

2.3 FABRICATION

A. Fabricate glass-fiber-reinforced gypsum units to comply with ASTM C 1381/C 1381M, with smooth-finished surfaces; repair hollows, voids, scratches, and other surface imperfections. Fabricate units in lengths and sizes that will minimize number of joints between abutting units.

B. Embedments: Incorporate embedments into units to develop the full strength of glass-fiber-reinforced gypsum fabrications. Cover embedments with not less than 3/16-inch thickness of glass-fiber-reinforced gypsum composite.

C. Connection Hardware: Designed and fabricated to support and connect glass-fiber-reinforced gypsum fabrications to hangers, support framing, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GLASS-FIBER-REINFORCED GYPSUM INSTALLATION

A. Comply with ASTM C 1467/C 1467M.

B. Install glass-fiber-reinforced gypsum fabrications level, plumb, true, and aligned with adjacent materials. Use concealed shims where required for alignment.

C. Attach glass-fiber-reinforced gypsum fabrications to framing and substrates with steel drill screws unless otherwise indicated. Do not use pneumatic staple guns. Countersink screw heads below adjoining finished surface.

1. Predrill fastener holes in units. Clean fastener holes to remove dirt and oil.
2. Locate fasteners not less than 5/16 inch from edges or ends of units.

D. Where glass-fiber-reinforced gypsum fabrications are joined to form composite units, join fabrications with adhesive. Band or brace units together until adhesive cures.

E. Use joint-treatment materials to finish glass-fiber-reinforced gypsum fabrications to produce surfaces ready to receive primers and paint finishes specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Finish joints between units, other than control joints, and countersunk fastener heads to comply with ASTM C 840 for Level 5 and to match surface texture of units.
2. Repair hollows, voids, scratches, and other surface imperfections on units.

END OF SECTION 092713

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
3. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
4. Section 092613 "Gypsum Veneer Acoustic Plastering" for gypsum base for veneer plaster and for other components of gypsum-veneer-plaster finishes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
3. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.

a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and

manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

4. Product Data for Credit IEQ 4.1: For adhesives used to laminate gypsum board panels to substrates, documentation including printed statement of VOC content.
5. Laboratory Test Reports for Credit IEQ 4: For adhesives used to laminate gypsum board panels to substrates, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Low Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of

the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 GYPSUM BOARD, GENERAL

A. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert number>** percent.

B. Regional Materials: Gypsum panel products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Regional Materials: Gypsum panel products shall be manufactured within 500 miles of Project site.

D. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Georgia-Pacific Gypsum LLC.
2. National Gypsum Company.
3. USG Corporation.

B. Gypsum Wallboard: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

C. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

D. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M, Level 1.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

E. Moisture- and Mold-Resistant Gypsum Board: Water Resistant Gypsum Backing Board per ASTM C 1396 with moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
2. Shapes:

    a. Cornerbead.
    b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    c. Reveals as indicated.
    d. Expansion (control) joint.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Tile Glass-Mat, Water-Resistant Backer Board: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

2. Recycled Content of Blankets: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert number>** percent.

D. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Pecora Corporation; AC-20 FTR.
b. USG Corporation; SHEETROCK Acoustical Sealant.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Acoustical joint sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Wallboard Type: Vertical and horizontal soffit & ceiling surfaces unless otherwise indicated.
2. Type X: Where required for fire-resistance-rated assembly.
3. Abuse-Resistant Type: On corridor side of all interior corridors and as indicated on Drawings.
4. Moisture- and Mold-Resistant Type: At all walls to receive ceramic tile finishes and as indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 APPLYING TILE BACKING PANELS

A. Where glass-mat, water-resistant backer boards abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

B. Install Water Resistant Gypsum Backing Board at all location to receive ceramic tile finish.

3.5 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.
3. Reveals: Use as indicated in the drawings.

3.6 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

4. Level 5: All gypsum board surfaces at walls and ceilings in Meeting Rooms 151 and 152, and where indicated on Drawings.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.7 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093000 - TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ceramic tile.
2. Metal edge strips.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Division 09 Section "Gypsum Board" for Water Resistant Gypsum Backing Board.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit IEQ 4.3: For adhesives, documentation including printed statement of VOC content.

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.

E. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Metal edge strips in 6-inch lengths.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product, signed by product manufacturer.

D. Material Test Reports: For each tile-setting and -grouting product.

1.6 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:

1. Joint sealants.
2. Metal edge strips.

D. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.2 TILE PRODUCTS

A. Tile Type: Glazed wall tile.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Active series porcelain tile by StonePeak Ceramics, Inc.; color “Lime”, or comparable product by one of the following:

a. American Marazzi Tile, Inc.
b. Florim USA.

2. Module Size: 12-inch by 24-inch.
3. Thickness: 3/8-inch.
4. Face: Pattern of design indicated, with manufacturer's standard edges.
5. Tile Color and Pattern: As indicated by manufacturer's designations.
6. Grout Color: As selected by Architect from manufacturer's full range.

2.3 SETTING MATERIALS

A. Organic Adhesive: ANSI A136.1, Type I, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Bonsal American; an Oldcastle company.
b. Bostik, Inc.
c. Laticrete International, Inc.
d. MAPEI Corporation.

2.4 GROUT MATERIALS

A. Polymer-Modified Tile Grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Bonsal American; an Oldcastle company.
b. Bostik, Inc.
c. Laticrete International, Inc.
d. MAPEI Corporation.

2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

2.5 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 07 Section "Joint Sealants."

1. Sealants shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.

C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with

fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Dow Corning Corporation; Dow Corning 786.
    b. GE Silicones; a division of GE Specialty Materials; Sanitary 1700.
    c. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
    d. Tremco Incorporated; Tremsil 600 White.

2.6 MISCELLANEOUS MATERIALS

A. Metal Edge Strips: Stainless-steel, ASTM A 666, L-shape, height to match tile and setting-bed thickness. For wall tile terminations at outside corners as indicated.

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

C. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Bonsal American; an Oldcastle company; Grout Sealer.
    b. Bostik, Inc.; CeramaSeal Grout & Tile Sealer.
    c. MAPEI Corporation; KER 003, Silicone Spray Sealer for Cementitious Tile Grout.

2.7 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 TILE INSTALLATION

A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

E. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Wall Tile: 1/8 inch.

F. Metal Edge Strips: Install.

G. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 TILE BACKING PANEL INSTALLATION

A. Install Water Resistant Gypsum Backing Board and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.5 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.6 INTERIOR TILE INSTALLATION SCHEDULE

A. Interior Wall Installations, Metal Studs or Furring:

1. Tile Installation W242: Organic adhesive on gypsum board; TCA W242.

END OF SECTION 093000

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for ceilings.

B. Related Requirements:

1. Section 095133 "Acoustical Metal Pan Ceilings" for ceilings consisting of perforated metal pans and associated suspension system for interior ceilings.
2. Section 095143 "Veneer Wood Panel Ceilings" for ceilings consisting of veneer wood panels and associated suspension system for interior ceilings.
3. Section 095436 "Suspended Decorative Grilles" for suspended wood grilles.

C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS, GENERAL

A. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
2. Suspension System: Obtain each type from single source from single manufacturer.

B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.

C. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.

D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.

E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. “Ultima Tegular” or comparable product by one of the following:

1. CertainTeed Corp.
2. Chicago Metallic Corporation.
3. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:

1. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted.
2. Pattern: E (lightly textured).

C. Color: White.

D. LR: Not less than 0.90.

E. NRC: Not less than 0.70.

F. CAC: Not less than 35.

G. Edge/Joint Detail: Beveled tegular, sized to fit flange of exposed suspension-system members.

H. Thickness: 3/4 inch.

I. Modular Size: 24 by 24 inches and 24 by 48 inches as indicated on Drawings.

1. Provide 6" x 24", 6" x 12", 6" x 48", and 12" x 48", or other sizes as indicated on Drawings.
2. Provide custom metal lay-in panels painted to match mineral fiber panels in color and gloss level in sizes as indicated on Drawings

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- diameter wire.

2.5 METAL SUSPENSION SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc., “Sonata XL” or comparable product by one of the following:

1. CertainTeed Corp.
2. Chicago Metallic Corporation.
3. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Extruded Aluminum Dimensional Tee Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with 9/16-inch- wide faces.

1. Structural Classification: Heavy-duty system.
2. Face Design: Dimensional tee.
3. Face Finish: Painted white.
4. Reveal Finish: Match face finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
7. Do not attach hangers to steel deck tabs.
8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
9. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 095133 - ACOUSTICAL METAL PAN CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes acoustical metal pans and associated suspension system for interior ceilings.

B. Related Requirements:

1. Section 095113 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.
2. Section 095143 "Veneer Wood Panel Ceilings" for ceilings consisting of veneer wood panels and associated suspension system for interior ceilings.
3. Section 095436 "Suspended Decorative Grilles" for suspended wood grilles.

C. Products furnished, but not installed, under this Section include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data for Credit IEQ 4.1: For sealants and adhesives, documentation including printed statement of VOC content.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:

1. Metal Pans: Set of 6-inch- square Samples of each type, finish, color, pattern, and texture. Show pan edge profile.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

3. Sound Absorber: Sample of each type matching size of Sample metal pan.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which suspension systems will be attached.
3. Size and location of access modules for acoustical panels.
4. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.

5. Perimeter moldings.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical metal pan ceiling, for tests performed by a qualified testing agency.

D. Evaluation Reports: For each acoustical metal pan ceiling suspension system.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Metal Pans: Full-size units equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each grid, exposed molding, and trim equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical ceiling area as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical metal pans, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle acoustical metal pans, suspension-system components, and accessories carefully to avoid damaging units and finishes in any way.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL METAL PANS, GENERAL

A. Source Limitations: Obtain each type of acoustical metal ceiling pan and supporting suspension system from single source from single manufacturer.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent for metal pans.

C. Glass-Fiber Insulation: Made with binder containing no urea formaldehyde.

D. Acoustical Panel Standard: Provide manufacturer's standard pans of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.

E. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.

1. Aluminum Sheet: Rolled aluminum sheet, complying with ASTM B 209; alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

F. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of pan, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing according to ASTM E 84.

G. Adhesive: Manufacturer's standard nonflammable adhesive for sound-absorbent pads.

1. Adhesive shall have a VOC content of 50 g/L or less.

2.3 ALUMINUM PANS FOR ACOUSTICAL METAL PAN CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide Ceilings Plus; Trilusions or comparable product by one of the following:

1. Chicago Metallic Corporation.
2. Gage Corporation International (The).
3. Simplex Ceilings, a division of Intalite Inc..

B. Classification: Units complying with ASTM E 1264 for Type VII, perforated aluminum facing (pan) with mineral- or glass-fiber-base backing.

1. Pattern: 3/16-inch round holes at 3/8-inch on center, staggered, 20% open.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.

D. Pan Thickness: Not less than 0.032 inch.

E. Pan Edge Detail: Manufacturer's standard edge detail.

F. Pan Size: 24 by 24 inches.

G. Pan Shape: 45 degree right triangular.

H. Pan Face Finish: Ceilings Plus color Lumin White.

I. LR: Not less than 0.75.

J. NRC: Not less than 0.95.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Recycled Content of Metal Suspension System: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635/C 635M requirements.

C. Suspension Systems: Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.

D. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635/C 635M, Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing

according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: Postinstalled expansion anchors.
b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

E. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635/C 635M, Table 1, Direct Hung, is less than yield stress of wire, but provide not less than 0.135-inch- diameter wire.

F. Exposed Metal Edge Moldings and Trim: Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching acoustical metal pan ceiling units unless otherwise indicated.

1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.5 DIRECT-HUNG, STANDARD-GRID, METAL SUSPENSION SYSTEM FOR ACOUSTICAL METAL PAN CEILING

A. Manufacturers: Same as panel manufacturer.

B. Suspension System: Manufacturer's standard tee bar main and cross runners for torsion-spring-hinged pans.

1. Structural Classification: Heavy-duty system.
2. Face Design: With 1/4-inch- wide, slotted, box-shaped flange.
3. Face Finish: Painted to match color of metal pan.

C. Suspension System for Torsion-Spring-Hinged Metal Pans: Provide runners with factory-cut slots fabricated to accept torsion-spring-hinged attachment.

2.6 ACOUSTICAL SEALANT

A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.

2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
3. Acoustical sealant shall have a VOC content of 250 g/L or less.
4. Acoustical sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

2.8 ALUMINUM FINISHES

A. Color-Coated Finish: Manufacturer's standard powder-coat baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical metal pan ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical metal pan ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and coordination drawings.

3.3 INSTALLATION

A. General: Install acoustical metal pan ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that do not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
7. Do not attach hangers to steel deck tabs.
8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Cut acoustical metal pan units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.

F. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim. Comply with installation tolerances according to CISCA's "Metal Ceilings Technical Guidelines."

1. For torsion-spring-hinged pans, position pans according to manufacturer's written instructions.
2. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
3. Fit adjoining units to form flush, tight joints.
4. Install directionally patterned or textured metal pans in directions indicated.
5. Install sound-absorbent fabric layers in, and bond to, perforated metal pans.

3.4 CLEANING

A. Clean exposed surfaces of acoustical metal pan ceilings, including trim and edge moldings, after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 095133

SECTION 095143 – VENEER WOOD PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes veneer wood panels and associated suspension system for interior ceilings.

B. Related Sections:

1. Section 095113 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.
2. Section 095133 "Acoustical Metal Pan Ceilings" for ceilings consisting of perforated metal pans and associated suspension system for interior ceilings.
3. Section 095436 "Suspended Decorative Grilles" for suspended wood doweled grilles.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
3. Certificates for Credit MR 7: Chain-of-custody certificates indicating that paneling complies with forest certification and chain-of-custody requirements. Include statement indicating cost for each certified wood product.
4. Product Data for Credit IEQ 4.1: For installation adhesives, documentation including printed statement of VOC content.
5. Product Data for Credit IEQ 4.4: For composite wood products and fabrication adhesives, documentation indicating that products contain no urea formaldehyde.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:

1. Veneer Wood Panels: Set of full-size Samples of each type, finish, color, pattern, and texture. Show panel edge profile.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.
3. Sound Absorber: Sample of each type matching size of Sample panel.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each veneer wood panel ceiling, for tests performed by a qualified testing agency.

B. Evaluation Reports: For each veneer wood panel ceiling suspension system.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Veneer Wood Panels: Full-size units equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each grid, exposed molding, and trim equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical ceiling area as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver veneer wood panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle veneer wood panels, suspension-system components, and accessories carefully to avoid damaging units and finishes in any way.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 VENEER WOOD PANELS, GENERAL

A. Source Limitations: Obtain each type of veneer wood panel and supporting suspension system from single source from single manufacturer.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent for wood panels.

C. Glass-Fiber Insulation: Made with binder containing no urea formaldehyde.

D. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of panel, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing according to ASTM E 84, and to comply with the following requirements:

1. Plastic Sheet-Wrapped, Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C 553, Type I, Type II, or Type III, and as follows:

a. Mineral-Fiber Type and Thickness: Glass fiber; 1 inch.
b. Plastic Sheet Thickness and Color: Not less than 0.003 inch; flat black.

E. Adhesive: Manufacturer's standard nonflammable adhesive for sound-absorbent pads.

1. Adhesive shall have a VOC content of 50 g/L or less.

2.3 VENEER WOOD PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc.; Woodworks or comparable product by one of the following:

1. Ceilings Plus.
2. Hunter Douglas Architectural Products, Inc.
3. USG Interiors, Inc.

B. Panel Thickness: Not less than ¾ inch.

C. Pan Edge Detail: Tegular.

D. Panel Size: 24 by 24 inches.

E. Perforations: Pattern W3.

F. Panel Face Finish:

1. Grade: A
2. Veneer species: Manufacturer's standard oak veneer with a custom stain to match adjacent or surrounding woodwork.
3. Finish: Catalyzed lacquer with a "water white" top coat, matte finish (low sheen) to match Architect's sample.
4. Substrate: 11/16" thick, Duraflake FR, Class A rated fire-retardant, SFI (Sustainable Forest Initiative) certified particleboard.

G. NRC: Not less than 0.40.

H. CAC: Not less than 28.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

   a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- diameter wire.

2.5 DIRECT-HUNG METAL SUSPENSION SYSTEM FOR VENEER WOOD PANEL CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc., Prelude 15/16” or comparable product by one of the following:

1. CertainTeed Corp.
2. Chicago Metallic Corporation.
3. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Extruded Aluminum Dimensional Tee Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with 15/16-inch- wide faces.

1. Structural Classification: Heavy-duty system.
2. Face Design: Dimensional tee.
3. Face Finish: Painted black.

2.6 METALLIC-COATED STEEL SHEET FINISHES

A. Color-Coated Finish: Manufacturer's standard powder-coat baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which veneer wood panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of veneer wood panel ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of veneer wood panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans and coordination drawings.

3.3 INSTALLATION

A. General: Install veneer wood panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that do not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and hanger type involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to postinstalled mechanical, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of veneer wood panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Cut veneer wood panel units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Treat exposed cut edges with edge banding to match factory edges.

3.4 CLEANING

A. Clean exposed surfaces of veneer wood panel ceilings, including trim and edge moldings, after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095143

SECTION 095436 - SUSPENDED DECORATIVE GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes decorative wood grille and suspension system.

B. Related Sections:

1. Section 095113 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.
2. Section 095133 "Acoustical Metal Pan Ceilings" for clip-in, lay-in, snap-in, and torsion-spring-hinged metal pan ceilings with exposed suspension systems.
3. Section 095143 "Veneer Wood Panel Ceilings" for ceilings consisting of veneer wood panels and associated suspension system for interior ceilings.

1.3 ACTION SUBMITTALS

A. Samples for Initial Selection: For components with factory-applied color and other decorative finishes.

B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:

1. Wood Grille: Set of 12-inch long by 12-inch wide samples of each type with wood slats and minimum of two cross pieces.

C. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

3. Certificates for Credit MR 7: Chain-of-custody certificates indicating that paneling complies with forest certification and chain-of-custody requirements. Include statement indicating cost for each certified wood product.
4. Product Data for Credit IEQ 4.1: For installation adhesives, documentation including printed statement of VOC content.

5. Product Data for Credit IEQ 4.4: For composite wood products and fabrication adhesives, documentation indicating that products contain no urea formaldehyde.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Linear pattern.
2. Joint pattern.
3. Ceiling suspension members.
4. Method of attaching hangers to building structure.
5. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
6. Ceiling perimeter and penetrations through ceiling; trim and moldings.

B. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain wood grille and suspension systems from one source with resources to provide products of consistent quality in appearance, physical properties, and performance.

B. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class C materials, as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood grilles, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle wood grilles, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install wood grilles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.8 COORDINATION

A. Coordinate layout and installation of wood grilles and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 WOOD GRILLES

A. WOOD GRILLE PANELS

1. Species: White Oak.
2. Member Size: ¾-inch wide by 2-1/4-inches deep.
3. Spacing: 7/16-inch.
4. Edge Profile: Square.
5. Assembly Style: Cross Piece.
6. Panel Sizes: As indicated.
7. Flame Spread: Class C.
8. Finish: Catalyzed lacquer with a "water white" top coat, matte finish (low sheen) to match Architect's sample.
9. Reveal Scrim: Black reveal scrim.

2.2 ACCESSORIES

A. Wood Trim: Provide wood trim and wood veneer side panels as indicated in finish to match wood grille.

B. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of pan, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing according to ASTM E 84.

C. Adhesive: Manufacturer's standard nonflammable adhesive for sound-absorbent pads.

1. Adhesive shall have a VOC content of 50 g/L or less.

2.3 METAL SUSPENSION SYSTEMS

A. Suspension Systems: Provide systems complete with carriers, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support wood grilles.

B. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.

C. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

2. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635, Table 1, Direct Hung will be less than yield stress of wire, but provide not less than 0.135-inch- diameter wire.

D. Carriers: Factory finished with matte-black baked finish.

1. Main Carriers: Steel, not less than 0.0209-inch nominal thickness, cold-rolled sheet, with factory-applied protective coating, complying with ASTM C 635.

a. Electrolytic Zinc-Coated Steel: ASTM A 591/A 591M, not less than 80Z zinc coating.

E. Carrier Splices: Same metal, profile, and finish as indicated for carriers.

F. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers at regular intervals; spaced as standard with manufacturer for use indicated; and factory finished with matte-black baked finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which wood grilles attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of wood grilles.

3.3 INSTALLATION

A. Comply with ASTM C 636 and manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.
3. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
4. Do not attach hangers to steel deck tabs.

5. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
6. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers but without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install suspension system carriers so they are aligned and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Install wood grilles in configurations, slopes, and dimensions shown. Provide wood veneer side closure panels in finish matching wood grille. Cut wood grilles for accurate fit at borders and at interruptions and penetrations by other work through ceilings.

F. Install wood grilles in coordination with suspension system and exposed moldings and trim.

1. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.

3.4 CLEANING

A. Clean exposed surfaces, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 095436

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Resilient base.
2. Resilient stair accessories.
3. Resilient molding accessories.

B. Related Sections:
1. Section 096519 "Resilient Tile Flooring" for resilient floor tile.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.

C. Samples for Initial Selection: For each type of product indicated.

D. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.

1.4 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Mockups: Provide resilient products with mockups specified in other Sections.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.7 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

A. Resilient Base:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Armstrong World Industries, Inc.
b. Johnsonite.
c. Roppe Corporation, USA.

B. Resilient Base Standard: ASTM F 1861.

1. Material Requirement: Type TS (rubber, vulcanized thermoset) or Type TP (rubber, thermoplastic).
2. Manufacturing Method: Group I (solid, homogeneous).
3. Style: Straight (toeless).

C. Minimum Thickness: 0.125 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Job formed.

G. Inside Corners: Job formed.

H. Colors and Patterns:

1. Basis of Design Product: Johnsonite Traditional Wall Base; color: 21 Platinum CG

2.2 RESILIENT STAIR ACCESSORIES

A. Resilient Stair Treads:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Johnsonite.
b. Nora Rubber Flooring; Freudenberg Building Systems, Inc.
c. Roppe Corporation, USA.

B. Resilient Stair Treads Standard: ASTM F 2169.

1. Material Requirement: Type TS (rubber, vulcanized thermoset).
2. Surface Design:

a. Class 1, Smooth (flat).
b. Class 2, Pattern: Raised-disc design.

3. Manufacturing Method: Group 1, tread with embedded abrasive strips and Group 2, tread with contrasting color for the visually impaired.

C. Nosing Style: Square, adjustable to cover angles between 60 and 90 degrees.

D. Nosing Height: 1-1/2 inches.

E. Thickness: 1/4 inch and tapered to back edge.

F. Size: Lengths and depths to fit each stair tread in one piece.

G. Risers: Smooth, flat, toeless, height and length to cover risers; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.

1. Thickness: 0.125 inch.

H. Colors and Patterns: As selected by Architect from full range of industry colors.

2.3 RESILIENT MOLDING ACCESSORY

A. Resilient Molding Accessory:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Flexco, Inc.
    b. Johnsonite.
    c. Roppe Corporation, USA.

B. Description: Carpet edge for glue-down applications, reducer strip for resilient floor covering, joiner for tile and carpet, transition strips.

C. Material: Rubber.

D. Profile and Dimensions: As indicated.

E. Colors and Patterns: As selected by Architect from full range of industry colors.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

    a. Cove Base Adhesives: Not more than 50 g/L.
    b. Rubber Floor Adhesives: Not more than 60 g/L.

C. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.

    a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are same temperature as the space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.
2. Inside Corners: Use straight pieces of maximum lengths possible.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:

1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.
3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet and resilient floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Perform the following operations immediately after completing resilient product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products until Substantial Completion.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid vinyl floor tile.
2. Cork/Rubber floor tile.
3. Cork/Rubber floor tile for elevator cab floors.
4. Vinyl composition floor tile.

B. Related Sections:

1. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.
2. Division 09 Section "Resilient Sheet Flooring" for resilient sheet floor coverings.
3. Division 09 Section "Static-Control Resilient Flooring" for resilient floor coverings designed to control electrostatic discharge.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
2. Product Data for Credit IEQ 4.3: For adhesives, documentation including printed statement of VOC content.
3. Product Data for Credit IEQ 4.3: For resilient tile flooring, documentation from an independent testing agency indicating compliance with the FloorScore Standard.

C. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

1. Show details of special patterns.

D. Samples for Initial Selection: For each type of floor tile indicated.

E. Samples for Verification: Full-size units of each color and pattern of floor tile required.

F. Product Schedule: For floor tile.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.5 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.6 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.8 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Close spaces to traffic during floor tile installation.

D. Close spaces to traffic for 48 hours after floor tile installation.

E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. FloorScore Compliance: Resilient tile flooring shall comply with requirements of FloorScore Standard.

2.2 SOLID VINYL FLOOR TILE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.
2. Johnsonite.
3. TOLI International.
4. To Market Flooring.

B. Tile Standard: ASTM F 1700.

1. Class: As indicated by product designations.
2. Type: Type B-Embossed Surface.

C. Thickness: 0.125 inch.

D. Size: 18 by 18 inches.

E. Seaming Method: Standard.

F. Colors and Patterns:
1. Basis of design product: To Market Flooring; Formis, style: Harvest; color: #62635 - grey/silver.

2.3 CORK/RUBBER FLOOR TILE

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Expanko; XCR4 Cork Rubber Flooring.
2. Johnsonite; Eco-Naturals Corktones.
3. Roppe Corporation, USA; SafeTcork.

B. Tile Standard: ASTM F 1344, Class I-B, homogeneous through mottled.

C. Hardness: Not less than 85 as required by ASTM F 1344, measured using Shore, Type A durometer per ASTM D 2240.

D. Wearing Surface: Molded pattern.

1. Molded-Pattern Figure: Raised discs.

E. Thickness: 0.125 inch.

F. Size: 24 by 24 inches.

G. Seaming Method: Standard.

H. Colors and Patterns: As selected by Architect from full range of industry colors.

I. Install in elevator cab floors and where indicated.

2.4 VINYL COMPOSITION FLOOR TILE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Azrock.
2. Armstrong World Industries, Inc.
3. Mannington Mills, Inc.

B. Tile Standard: ASTM F 1066, Class 2, through-pattern tile.

C. Wearing Surface: Smooth.

D. Thickness: 0.125 inch.

E. Size: 12 by 12 inches.

F. Colors and Patterns:
1. Basis of Design: Azrock; Cortina Colors, V-862 Cloud White

2.5 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.

1. Adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

a. VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
b. Rubber Floor Adhesives: Not more than 60 g/L.

C. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

    a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75% relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until they are same temperature as space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern).

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of floor tile.

B. Perform the following operations immediately after completing floor tile installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect floor tile products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor tile surfaces before applying liquid floor polish.

1. Apply two coat(s).

E. Cover floor tile until Substantial Completion.

END OF SECTION 096519

SECTION 096623 - RESINOUS MATRIX TERRAZZO FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Thin-set, epoxy-resin terrazzo flooring and precast base.
2. Precast epoxy-resin terrazzo units.

B. Related Requirements:

1. Division 07 Section "Joint Sealants" for sealants installed with terrazzo.
2. Division 09 Section "Resinous Flooring" for decorative resinous flooring systems applied as self-leveling slurries or as troweled or screeded mortars.

1.3 DEFINITIONS

A. Aggregate: Marble chips and other types of aggregate.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to terrazzo including, but not limited to, the following:

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Review special terrazzo designs and patterns..

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
3. Product Data for Credit IEQ 4.3: For sealers, documentation including printed statement of VOC content.
4. Product Data for Credit IEQ 4.3: For terrazzo flooring, documentation from an independent testing agency indicating compliance with the FloorScore Standard.

C. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work. Show layout of the following:

1. Divider strips.
2. Control-joint strips.
3. Abrasive strips.
4. Stair treads, risers, and landings.
5. Terrazzo patterns..

D. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

E. Samples for Initial Selection: NTMA color plates showing the full range of colors and patterns available for each terrazzo type.

F. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo sample to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in size indicated below:

1. Terrazzo: 6-inch- square Samples.
2. Precast Terrazzo: 6-inch- square Samples.
3. Accessories: 6-inch- long Samples of each exposed strip item required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each type of terrazzo material or product, from manufacturer.

C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For terrazzo to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage an installer who is a contractor member of NTMA.

2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.

B. Source Limitations: Obtain primary terrazzo materials from single source from single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.

C. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

B. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

C. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

D. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.

E. Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.

B. FloorScore Compliance: Terrazzo floors shall comply with requirements of FloorScore Standard.

2.2 EPOXY-RESIN TERRAZZO

A. Epoxy-Resin Terrazzo: Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and aggregate proportions and mixing.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Crossfield Products Corp., Dex-O-Tex Division; Spectrum Terrazzo.
    b. General Polymers Corporation; Terrazzo 1100.
    c. Key Resin Company; Key Epoxy Terrazzo.
    d. Master Terrazzo Technologies LLC; Morricite.
    e. Quadrant Chemical Corporation; Quadset Epoxy Terrazzo.
    f. TEC Specialty Construction Brands, Inc.; Tuff-Lite Epoxy Terrazzo.
    g. Terrazzo & Marble Supply Companies; Terroxy Resin Systems.

2. Thickness: 3/8 inch nominal.
3. Custom Mix Color and Pattern: Refer to the schedule at the end of this section.

B. Materials:

1. Flexible Reinforcing Membrane: Manufacturer's resinous membrane for substrate-crack preparation and reflective-crack reduction.

    a. Reinforcement: Fiberglass scrim.

2. Primer: Manufacturer's product recommended for substrate and use indicated.
3. Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated and in color required for mix indicated.

    a. Physical Properties without Aggregates:

        1) Hardness: 60 to 85 per ASTM D 2240, Shore D.
        2) Minimum Tensile Strength: 3000 psi per ASTM D 638 for a 2-inch specimen made using a "C" die per ASTM D 412.
        3) Minimum Compressive Strength: 10,000 psi per ASTM D 695, Specimen B cylinder.
        4) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D 1308.

            a) Distilled water.
            b) Mineral water.
            c) Isopropanol.
            d) Ethanol.
            e) 0.025 percent detergent solution.
            f) 1.0 percent soap solution.
            g) 10 percent sodium hydroxide.
            h) 10 percent hydrochloric acid.
            i) 30 percent sulfuric acid.
            j) 5 percent acetic acid.

    b. Physical Properties with Aggregates: For resin blended with Georgia white marble, ground, grouted, and cured per requirements in NTMA's "Terrazzo Specifications and Design Guide"; comply with the following:

        1) Flammability: Self-extinguishing, maximum extent of burning 1/4 inch per ASTM D 635.

2) Thermal Coefficient of Linear Expansion: 0.0025 inch/inch per deg F for temperature range of minus 12 to plus 140 deg F per ASTM D 696.

4. Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.

   a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131.
   b. 24-Hour Absorption Rate: Less than 0.75 percent.
   c. Dust Content: Less than 1.0 percent by weight.
   d. Recycled Content of Epoxy-Resin Terrazzo: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

5. Finishing Grout: Resin based.

2.3 PRECAST EPOXY-RESIN TERRAZZO

A. Manufacturers: Subject to compliance with requirements, provide precast epoxy terrazzo units from the same sources as the poured in place epoxy resin terrazzo.

B. Precast Terrazzo Units: Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to 1/8-inch radius.

1. Stair treads and landings.
2. Wall base.
3. Treads to extend full width of stair without joints.
4. Color, Pattern, and Finish: Match adjacent poured-in-place terrazzo flooring.

2.4 STRIP MATERIALS

A. Thin-Set Divider Strips: L-type angle, 1/4 inch deep.

1. Material: White-zinc alloy.
2. Top Width: 1/8 inch.

B. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.

1. Bottom-Section Material: Matching top-section material.
2. Top-Section Material: White-zinc alloy.
3. Top-Section Width: 1/8 inch.

C. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.

D. Abrasive Strips: One-line abrasive inserts at nosings. Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.

1. Width: 1/2 inch.
2. Depth: As required by terrazzo thickness.
3. Length: 4 inches less than stair width.
4. Color: As selected by Architect from full range of industry colors.

2.5 MISCELLANEOUS ACCESSORIES

A. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use.

1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Anchoring Devices:

1. Strips: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and required for secure attachment to substrate.
2. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.

C. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

D. Resinous Matrix Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.

E. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; is recommended by sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.

1. Surface Friction: Not less than 0.6 according to ASTM D 2047.
2. Acid-Base Properties: With pH factor between 7 and 10.
3. Sealers shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.2 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.

B. Concrete Slabs:

1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.

a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written recommendations.
c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.

C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

1. Moisture Testing: Perform tests indicated below.

a. Test Method: Test for moisture content by method recommended in writing by terrazzo manufacturer. Proceed with installation only after substrates pass testing.

D. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.

1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 EPOXY-RESIN TERRAZZO INSTALLATION

A. Comply with NTMA's written recommendations for terrazzo and accessory installation.

B. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions and NTMA's "Terrazzo Specifications and Design Guide."

C. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet; noncumulative.

D. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.

E. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.

F. Flexible Reinforcing Membrane:

1. Prepare and prefill substrate cracks with membrane material.
2. Install membrane at substrate cracks in areas to receive terrazzo.
3. Reinforce membrane with fiberglass scrim.
4. Prepare membrane according to manufacturer's written instructions before applying substrate primer.

G. Primer: Apply to terrazzo substrates according to manufacturer's written instructions.

H. Strip Materials:

1. Divider and Control-Joint Strips:

a. Locate divider strips in locations indicated.

b. Install control-joint strips back to back directly above concrete-slab control joints and in locations indicated.
c. Install control-joint strips with 1/4-inch gap between strips, and install sealant in gap.
d. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.

2. Abrasive Strips: Install with surface of abrasive strip positioned 1/16 inch higher than terrazzo surface.

3.4 PRECAST TERRAZZO INSTALLATION

A. Install precast terrazzo units using method recommended by NTMA and manufacturer unless otherwise indicated.

B. Do not install units that are chipped, cracked, discolored, or not properly finished.

C. Seal joints between units with joint sealant.

3.5 REPAIR

A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect.

3.6 CLEANING AND PROTECTION

A. Cleaning:

1. Remove grinding dust from installation and adjacent areas.
2. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.

B. Sealing:

1. Seal surfaces according to NTMA's written recommendations.
2. Apply sealer according to sealer manufacturer's written instructions.

C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

3.7 COLORS AND DESIGN MIX

A. Field Color – Drawing Designation T-1
1. White matrix – color to match #547-1 “Windswept” by PPG Paints.
2. Stones:
a. Grey #2 or larger.

B. Field Color – Drawing Designation T-2

1. Grey matrix – color to match #555-4 “Gray Frost” by PPG Paints.
2. Stones:
    a. Grey #2 or larger.

C. Accent Color – Drawing Designation T-3
1. Dark blue matrix – color to match #451-7 “Celestial Blue” by PPG Paints.
2. Stones:
    a. 50% Grey #2 or larger.
    b. 50% Mother of Pearl #2 size.

D. Accent Color – Drawing Designation T-4
1. Red matrix – color to match #232-7 “Rum Runner” by PPG Paints.
2. Stones:
    a. 50% Grey #2 or larger.
    b. 50% Mother of Pearl #2 size.

E. Accent Color – Drawing Designation T-5
1. Yellow matrix – color to match #117-6 “Honey Pot” by PPG Paints.
2. Stones:
    a. 50% Grey #2 or larger.
    b. 50% Mother of Pearl #2 size.

END OF SECTION 096623

SECTION 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. High-performance resinous flooring systems.

B. Related Requirements:

1. Division 07 Section "Joint Sealants" for sealants installed with terrazzo.
2. Division 09 Section "Resinous Matrix Terrazzo Flooring" for thin-set, epoxy-resin terrazzo flooring and base.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to resinous flooring including, but not limited to, the following:

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Samples for Initial Selection: For each type of exposed finish required.

D. Samples for Verification: For each resinous flooring system required, 6 in. square, applied to a rigid backing by Installer for this Project.

1.5 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each resinous flooring system.

B. Material Certificates: For each resinous flooring component, from manufacturer.

C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project:

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:

1. Apply full-thickness mockups on 48 in. (1,200 mm) square floor area selected by the Architect:

a. Include 48 in. (1,200 mm) length of integral cove base with inside corner.

2. Approved mockups may become part of the completed Work if undisturbed at time of Final Inspection/Acceptance.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Provide Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, the following are provided as examples of manufacturers providing products with the salient characteristics to be found in the submitted product. Manufacturers offering products that may be incorporated into the Work include, but are not limited to:

1. Dex-O-Tex.
2. Dur-A-Flex, Inc.
3. Sherwin-Williams Company, General Polymers.
4. **Sika Group.**

2.2 MATERIALS

A. VOC Content of Resinous Flooring: Provide resinous flooring systems, for use inside the weatherproofing system, that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Resinous Flooring: 100 g/L.

2.3 RESINOUS FLOORING

A. Resinous Flooring: Abrasion-, impact- and chemical-resistant, colored quartz troweled epoxy flooring designed to produce a seamless floor.

B. Basis of Design Product: Sika Group; Sikafloor Decoflake.

C. Color and Pattern: Custom blend selected from full range of manufacturer's standard colored quartz aggregate.

D. System Characteristics:

1. Wearing Surface: Textured for slip resistance.
2. Overall System Thickness: 3/16 in. minimum.

E. System Components:

1. Primer/Binder: Type recommended by manufacturer for substrate and body coats indicated:

   a. Formulation Description: 100 percent solids.

2. Body Coats:

   a. Resin: Epoxy.
   b. Formulation Description: 100 percent solids.

c. Application Method: Trowel applied.

3. Aggregates: Manufacturer's standard blended colored quartz granules
4. Topcoat: Sealing or finish coats:

a. Resin: Epoxy.
b. Formulation Description: 100 percent solids.
c. Type: Pigmented.
d. Finish: Gloss.

5. Cove Base: Apply cove base mix to wall surfaces at locations specified at a height of 4 inches unless otherwise indicated. Follow manufacturer's printed instructions and details including taping, mixing, priming, troweling, sanding, and top-coating of cove base.

F. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Compressive Strength (Resin, Hardener & Aggregate): 10,500 psi per ASTM C 579.
2. Compressive Strength (Resin & Hardener): 12,900 psi per ASTM D 695.
3. Tensile Strength (Resin, Hardener & Aggregate): 1,700 psi per ASTM C 307.
4. Tensile Strength (Resin & Hardener): 5,000 psi per ASTM D 638.
5. Flexural Strength: 3,700 psi per ASTM C 580.
6. Surface Hardness: 80-85 per ASTM D2240 Shore D.
7. Indentation Characteristics (Steadily Applied Load) : 0.005" per MIL-PRF-3134.

a. 2000 lbs on 1" steel ram imposed for 30 minutes over a concrete substrate, indented.

8. Indentation Characteristics (Impact Load): 0.011 inch per MIL-PRF-3134.

a. Indent from 2 lb. steel ball dropped twice from 8 ft. height.

9. Adhesion: 300 psi per ASTM D 4541 (100% failure in concrete).
10. Water Absorption: < 1.0% per MIL-PRF-3134.
11. Abrasion Resistance (CS17, 1000gr load, 1000 cycles): 0.04 gr per ASTM D 4060.
12. Antimicrobial Resistance per ASTM G2: Passes.
13. Flammability per ASTM D 635: Self-Extinguishing
Bonded to Concrete.

2.4 MISCELLANEOUS ACCESSORIES

A. Anti-Microbial Additive: Incorporate antimicrobial chemical additive to control growth of most algae, bacteria, fungi, mildew and mold.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.2 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring:

1. Roughen concrete substrates as follows:

    a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
    b. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
3. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

3.3 APPLICATION

A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated:

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Apply reinforcing membrane to substrate cracks.

D. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners:

1. Integral Cove Base: 4 in. (100 mm) high.

E. Apply self-leveling slurry body coats in thickness indicated for flooring system:

1. Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.

F. Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.

G. Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat and to produce wearing surface indicated.

H. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.4 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes modular, tufted carpet tile.

B. Related Requirements:

1. Division 09 Section "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include installation recommendations for each type of substrate.

B. LEED Submittals:

1. Product Data for Credit EQ 4.3:

a. For carpet tile, documentation indicating compliance with testing and product requirements of CRI's "Green Label Plus" program.
b. For installation adhesive, documentation including printed statement of VOC content.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.

D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup for each carpet type and color within a room designated to receive that type.
2. Mockup to be a minimum of ten foot square extended to a corner of the room.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.10 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.11 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by InterfaceFLOR listed in the carpet schedule at the end of this section.

B. Color: Refer to the carpet schedule at the end of this section.

C. Pattern: Refer to the carpet schedule at the end of this section..

D. Fiber Content: 100 percent nylon 6, 6.

E. Fiber Type: Type 6,6 nylon.

F. Pile Characteristic:

1. Carpet types C1 and C2 – Tufted sheared.
2. Carpet types C3 and C4 - Tufted pattern loop.
3. Carpet type C5 - Tufted textured loop.

G. Pile Thickness:

1. Carpet types C1 and C2 – 0.159 inches for finished carpet tile.
2. Carpet type C3 - 0.086 inches for finished carpet tile.
3. Carpet type C4 – 0.123 inches for finished carpet tile.
4. Carpet type C5 – 0.099 inches for finished carpet tile.

H. Stitches:

1. Carpet types C1, C2, and C3 - 11 per inch.
2. Carpet type C4 – 9 per inch.
3. Carpet type C5 – 11.6 per inch.

I. Surface Pile Weight:

1. Carpet type C3 - 16 oz./sq. yd..
2. Carpet types C1, C2, and C4 – 24 oz./sq. yd..
3. Carpet type C5 – 21 oz./sq. yd..

J. Primary Backing/Backcoating: Manufacturer's standard composite materials.

K. Size: 50 cm by 50 cm.

L. Applied Soil-Resistance Treatment: Manufacturer's standard material.

M. Antimicrobial Treatment: Manufacturer's standard material.

N. Performance Characteristics: As follows:

1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D 7330.
2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm.
3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D 2646.
4. Tuft Bind: Not less than 6.2 lbf according to ASTM D 1335.
5. Delamination: Not less than 4 lbf/in. according to ASTM D 3936.
6. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
8. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
9. Emissions: Provide carpet tile that complies with testing and product requirements of CRI's "Green Label Plus" program.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Transition Strips: Resilient strips of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:

1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: Install tiles with releasable, pressure-sensitive adhesive pads at each corner.

1. TacTiles systems by Interface Carpet or equal.

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

PART 4 - CARPET SCHEDULE

C1 Student Lounge (rm 245)	Interface tile, Red Carpet Collection, Redesign, 1/4 turn installation	Flannel #102570
C2 Conference Room (rm 200)	Interface tile, Red Carpet Collection, Redesign, 1/4 turn installation	Navy #102572
C3 Faculty and Admin. Offices	Interface tile, 1000 Series, S102	Grey, #9528
C4 Large Meeting Room 151 & 152 - Field	Interface carpet tile Field: 3000 Collection, S301	Charcoal # 9817
C5 Large Meeting Room 151 & 152 - Accents	Interface carpet tile Pattern: Tectonics 21Z, cut in triangular shapes as shown on drawings.	Color 2: Byte, 100067 Color 3: Nano, 100062 Color 4: Binary, 100060

END OF SECTION 096813

SECTION 097700 – SPECIAL WALL SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fiberglass reinforced plastic panel wall surfacing.

B. Related Sections:

1. Section 061053 “Miscellaneous Rough Carpentry.”
2. Section 092900 “Gypsum Board.”

1.3 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

B. ASTM International:

1. ASTM D256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
2. ASTM D570 Standard Test Method for Water Absorption of Plastics.
3. ASTM D638 Standard Test Method for Tensile Properties of Plastics.
4. ASTM D696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer.
5. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
6. ASTM D2583 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
7. ASTM D5420 Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).
8. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SYSTEM DESCRIPTION

A. Performance Requirements: Provide fiberglass reinforced plastic (FRP) panels, which have been manufactured and installed to maintain performance criteria stated by manufacturer without defects, damage or failure.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit IEQ 4.4: For laminating adhesive used in factory-laminated plastic panels, documentation indicating that product contains no urea formaldehyde.

C. Shop Drawings: Submit shop drawings showing layout, profiles and product components, including anchorage, accessories, finish colors, patterns and textures. Indicate location and dimension of joints and fastener attachment.

D. Samples for Initial Selection: For plastic paneling and trim accessories.

E. Samples for Verification: For plastic paneling and trim accessories, in manufacturer's standard sizes.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit manufacturer’s certificate that products meet or exceed specified requirements.

B. Submit certificate of installer’s qualifications.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for compliance with specified performance characteristics and physical properties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wall surfacing to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing identical products applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: As follows, per ASTM E 84:

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

1.9 DELIVERY, STORAGE & HANDLING

A. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Package sheets on skids or pallets for shipment to project site.

B. Storage and Handling: Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer. Store panels in a dry indoor location at Project site. Remove any foreign matter from face of panel by using a soft bristle brush, avoiding abrasive action. Lay panels flat. Do not stand panels on edge. Protect panels from moisture. Do not store panels in contact with the floor or against an outside wall.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Installation shall not begin until building is enclosed, permanent heating and cooling equipment is in operation and residual moisture from plaster, concrete or terrazzo work has dissipated.

1. Install panels between 60 and 75 degrees F (15 and 24 degrees C) and relative humidity below 65%, ideally at the same conditions as the room's normal operating temperatures after building is occupied.
2. Provide ventilation to disperse fumes during application of adhesive as recommended by adhesive manufacturer.

B. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

PART 2 - PRODUCTS

2.1 FIBERGLASS REINFORCED PLASTIC (FRP) PANELS

A. General: Provide Fiberglass reinforced plastic panels complying with ASTM D5319.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Crane Composites, Inc.
2. Marlite, Inc.
3. Nudo Products, Inc.

2.2 Product Characteristics:

A. Surface Texture: As selected by Architect from manufacturer's full range.

B. Color: As selected by Architect from manufacturer's full range.

C. Thickness: 0.09 inch.

D. Fire Rating: Class A (I).

E. Performance Criteria:

1. Flexural Strength: 12,000 psi, ASTM D790.
2. Tensile Strength: 7,000 psi, ASTM D638.
3. Barcol Hardness: 35, ASTM D2583.
4. Impact Strength (IZOD): 8 ft-lb/sq in (0.43 J/mm) ASTM D256, showing no visible damage on finish side.
5. Water Absorption: 0.16 percent in 24 hours at 77 deg F (25 deg C), ASTM D570.

F. Panel Size: 4'-0"equired to extend from floor to ceiling without horizontal joints.

2.3 ACCESSORIES

A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide inside corners, outside corners, and caps as needed to conceal edges.

1. Color: Match panels.

B. Adhesive: As recommended by plastic paneling manufacturer.

1. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Sealant: Single-component, mildew-resistant, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 079200 "Joint Sealants."

1. Sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Sealant color to match panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall surfacing, including dirt, oil, grease, mold, mildew, and incompatible primers.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.

1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.

2. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

D. Prior to installing panels, remove packaging and allow panels to acclimate to room temperature and humidity for at least 48 hours.

3.3 INSTALLATION

A. General: Comply with manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.

B. Install corner moldings as described in manufacturer's molding instructions.

C. Plan panel layout so seams are not directly over seams of substrate.

D. Apply adhesive directly to back of FRP panel with full adhesive coverage using crosshatch pattern. Extend adhesive to all edges of panel.

E. Install with perimeter gaps as required to accommodate panel expansion.

F. Fill 1/8 inch gap between the panels with caulk, making sure gap is completely filled.

3.4 CLEANING

A. Clean panel surfaces in compliance with manufacturer's recommendations.

1. Use a clean, damp, nonabrasive cotton cloth and a mild liquid detergent or household cleaner.
2. Rinse with clean water using a clean, nonabrasive cotton cloth.
3. Dry panels with a soft, clean nonabrasive cotton cloth.
4. Do not use cleaners containing acid, alkali or sodium hypochlorite.

END OF SECTION 097200

SECTION 09910 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Concrete.
2. Concrete masonry units (CMU).
3. Steel.
4. Galvanized metal.
5. Aluminum (not anodized or otherwise coated).
6. Gypsum board.

B. Related Sections include the following:

1. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.
2. Division 8 Sections for factory priming windows and doors with primers specified in this Section.
3. Division 9 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Benjamin Moore & Co.
2. Duron, Inc.
3. PPG Pittsburgh Paints
4. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:

1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
3. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
4. Restricted Components: Paints and coatings shall not contain any of the following:

    a. Acrolein.
    b. Acrylonitrile.
    c. Antimony.
    d. Benzene.
    e. Butyl benzyl phthalate.
    f. Cadmium.
    g. Di (2-ethylhexyl) phthalate.
    h. Di-n-butyl phthalate.
    i. Di-n-octyl phthalate.
    j. 1,2-dichlorobenzene.
    k. Diethyl phthalate.
    l. Dimethyl phthalate.
    m. Ethylbenzene.
    n. Formaldehyde.
    o. Hexavalent chromium.
    p. Isophorone.
    q. Lead.
    r. Mercury.
    s. Methyl ethyl ketone.
    t. Methyl isobutyl ketone.
    u. Methylene chloride.
    v. Naphthalene.
    w. Toluene (methylbenzene).
    x. 1,1,1-trichloroethane.
    y. Vinyl chloride.

C. Colors: Principal colors for interior gypsum board surfaces are indicated below. Additional colors shall be as selected by Architect from manufacturer's full range.

1. Assume one accent wall in each room or space.
2. In rooms with chair rail, assume different color below chair rail and above chair rail.
3. In spaces over one story in height, assume different color at upper wall area.
4. Principal colors for interior gypsum board surfaces based on PPG Industries color codes are as follows:
    a. Drawing designation P1: #547-1 Windswept (white).

b. Drawing designation P2: #518-3 Thin Ice (pale gray).
c. Drawing designation P3 (accent): #547-5 Blueberry Muffin (medium blue).
d. Drawing designation P4 (accent): #111-3 Butter (pale yellow).
e. Drawing designation P5: #518-1 Delicate White (ceilings and soffits).

2.3 BLOCK FILLERS

A. Interior/Exterior Latex Block Filler: MPI #4.

1. VOC Content: E Range of E3.

2.4 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: EPR 3.

2.5 METAL PRIMERS

A. Rust-Inhibitive Primer (Water Based): MPI #107.

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: EPR 3.

B. Waterborne Galvanized-Metal Primer: MPI #134.

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: EPR 3.

C. Quick-Drying Primer for Aluminum: MPI #95.

1. VOC Content: E Range of E3.

2.6 LATEX PAINTS

A. Institutional Low-Odor/VOC Latex (Flat): MPI #143 (Gloss Level 1).

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: EPR 5.5.

B. Institutional Low-Odor/VOC Latex (Low Sheen): MPI #144 (Gloss Level 2).

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: EPR 4.5.

C. Institutional Low-Odor/VOC Latex (Eggshell): MPI #145 (Gloss Level 3).

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: EPR 4.5.

D. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: EPR 5.5.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

H. Aluminum Substrates: Remove surface oxidation.

I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:

1. Mechanical Work:

a. Uninsulated metal piping.
b. Uninsulated plastic piping.
c. Pipe hangers and supports.
d. Tanks that do not have factory-applied final finishes.
e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

2. Electrical Work:

    a. Switchgear.
    b. Panelboards.
    c. Electrical equipment that is indicated to have a factory-primed finish for field painting.

3.4 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:

1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Institutional Low-Odor/VOC Latex System: MPI INT 3.1M.

    a. Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
    b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
    c. Topcoat: Institutional low-odor/VOC interior latex (low sheen).

B. CMU Substrates:

1. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E.

a. Prime Coat: Interior/exterior latex block filler.
b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex (low sheen).

C. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System: MPI INT 5.1S.

a. Prime Coat: Rust-inhibitive primer (water based).
b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex (semigloss).

D. Galvanized-Metal Substrates:

1. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N.

a. Prime Coat: Waterborne galvanized-metal primer.
b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex (semigloss).

E. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Institutional Low-Odor/VOC Latex System: MPI INT 5.4G.

a. Prime Coat: Quick-drying primer for aluminum.
b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex (semigloss).

F. Gypsum Board Substrates:

1. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.

a. Prime Coat: Interior latex primer/sealer.
b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
c. Topcoat: Institutional low-odor/VOC interior latex (eggshell).

END OF SECTION 09912

SECTION 101100 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Porcelain enamel whiteboards.
2. Glass surface whiteboards.
3. Cork tackboards.
4. Perforated metal panel tackboards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that the product contains no urea formaldehyde.

C. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.

1. Show locations of panel joints.
2. Show locations of special-purpose graphics for visual display surfaces.
3. Include sections of typical trim members.

D. Samples for Initial Selection: For each type of visual display surface indicated, for units with factory-applied color finishes, and as follows:

1. Actual sections of porcelain-enamel face sheet, glass whiteboard surface, cork tackboard assembly, and perforated metal panel tackboards..
2. Include accessory Samples to verify color selected.

E. Samples for Verification: For each type of visual display surface indicated.

1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: 6-inch- long sections of each trim profile.
3. Accessories: Full-size Sample of each type of accessory.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Operation and Maintenance Data: For visual display surfaces to include in maintenance manuals.

C. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain visual display surfaces of each type from single source from single manufacturer.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display surfaces vertically with packing materials between each unit.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.

1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.8 WARRANTY

A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Surfaces lose original writing and erasing qualities.
b. Surfaces exhibit crazing, cracking, or flaking.

2. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Visual Display Products, LLC.
b. Claridge Products and Equipment, Inc.
c. PolyVision Corporation; a Steelcase company.

2. Gloss Finish: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.

B. Glass: 1/4" Tempered.

C. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish with surface-burning characteristics indicated.

D. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than 15 oz./sq. yd.; with surface-burning characteristics indicated.

E. Hardboard: ANSI A135.4, tempered.

F. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.

G. Fiberboard: ASTM C 208.

H. Extruded Aluminum: ASTM B 221, Alloy 6063.

I. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, exposed.

2.2 WHITEBOARD ASSEMBLIES

A. Porcelain-Enamel Whiteboards: Balanced, high-pressure, factory-laminated whiteboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch-thick, porcelain-enamel face sheet with high-gloss finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Visual Display Products, LLC.

b. Claridge Products and Equipment, Inc.
c. Mooreco, Inc.

2. Manufacturer's Standard Core: Minimum 7/16 inch thick, with manufacturer's standard moisture-barrier backing.
3. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.

2.3 GLASS WHITEBOARD ASSEMBLIES

A. Glass Whiteboard: 1/4" Tempered glass, dry erase writing surface with eased corners, polished edges, and acid-etched back.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Clarus Glassboards LLC.
b. Krystal™ Writing Boards, Inc.
c. The Glass Wipe Board Company

2. Acid-etched white finish.
3. Stainless steel stand-off mounting hardware.

2.4 TACKBOARD ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Best-Rite Manufacturing.
2. Claridge Products and Equipment, Inc.
3. Tri-Best Visual Display Products.

B. Natural-Cork Tackboard: 1/4-inch- thick, natural cork sheet factory laminated to 1/4-inch- thick hardboard backing.

2.5 PERFORATED METAL PANEL TACKBOARD ASSEMBLIES

A. Perforated metal shell over tackable surface; accepts both magnets and tacks.

B. Size: 36 inches wide by 48 inches high.

C. Basis-of-Design Product: Subject to compliance with requirements, provide “Pin-Mag” as manufactured by Steelcase, Inc.

D. Metal Shell: 18 Gage perforated steel sheet with 1-1/2 inch on margins all four sides with returned perimeter edges to form ½ inch deep pan.

1. Finish: manufacturer’s standard finish, color “Platinum.
2. Perforations: 1/2-inch diameter holes on 5/8-inch centers, staggered.

E. Tackable Surface: 7/16 inch thick fabric faced fiberboard.

1. Fabric selected from manufacturer's full range of standard fabrics.

2.6 WHITEBOARD ACCESSORIES

A. Classroom Whiteboards:

1. Aluminum Frames: Fabricated from not less than 0.062-inch- thick, extruded aluminum; slim size and standard shape.
2. Factory-Applied Trim: Manufacturer's standard.
3. Accessories:

   a. Chalktray: Manufacturer's standard, continuous.
   b. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
   c. Map Rail: Provide the following accessories:

      1) Display Rail: Continuous and integral with map rail; fabricated from cork approximately 1 to 2 inches wide.
      2) End Stops: Located at each end of map rail.
      3) Map Hooks: Two map hooks for every 48 inches of map rail or fraction thereof.

B. Corridor Whiteboards:

1. Aluminum Frames: Fabricated from not less than 0.062-inch- thick, extruded aluminum; of size and shape indicated on Drawings.
2. Chalktray: Manufacturer's standard, 12-inch magnetic accessory tray.

2.7 FABRICATION

A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.

B. Visual Display Boards: Factory assemble visual display boards unless otherwise indicated.

C. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
2. Provide manufacturer's standard vertical-joint H-trim system between abutting sections of whiteboards.
3. Provide manufacturer's standard mullion trim at joints between whiteboards and tackboards of combination units.
4. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

D. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.

1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine walls and partitions for proper preparation and backing for visual display surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES

A. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.

3.5 CLEANING AND PROTECTION

A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 101100

SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior and exterior signage.

1.3 DEFINITIONS

A. Adhesive: Any liquid, aerosol, sheet, tape or foam tape adhesive or solvent bonding system. Artwork shall mean electronic or camera-ready reproducible artwork for any specific graphic components of individual signs, symbols, logotypes, line drawings, etc. to be provided in a scale of at least one-quarter full size.

B. Graphic components: All typography, illustrations, line drawings, maps, charts, etc. forming part of a sign.

C. Sign: Any sign, graphic work to be applied to an architectural component, or other element described or specified in the Contract Documents.

D. Character: Any visual element of a sign, including letters, numerals, punctuation marks, symbols, etc.

E. Paint fill: Any paint, ink, dye, varnish or other coating material used to fill engraved, etched, or incised characters.

1.4 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured materials. Include statement indicating cost for each regionally manufactured material.

a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.

C. Shop Drawings: For panel signs and dimensional letter signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
3. Show message list, typestyles, graphic elements including raised characters and Braille, and layout for each sign at least half size.

D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

E. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

F. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. MATERIALS AND CONSTRUCTION

1. ACRYLIC SHEET

a. Acrylic sheet shall be premium quality as manufactured by Rohm and Haas (Plexiglas), Du Pont (Lucite), American Cyanamid, or approved equal.
b. The edges of acrylic sheet components and any drilled holes shall be smooth and free of saw marks, chips, cracks or other blemishes and shall be square to the face. All visible edges are to be hand or machine polished unless specified otherwise. Flame polishing shall not be permitted.
c. Where acrylic sheet is 'glazed' or contained in a frame it shall be cut to allow for expansion and contraction.
d. Laminated sheets and welded joints shall be free of gaps and bubbles and shall be continuously sealed and clear.
e. Use special care in the fabrication and installation of acrylic sheets to prevent scratching, staining or other imperfections.
f. When there is no possibility of danger from other work to be performed, remove all protective coverings on acrylic sheet and remove any scratches using an approved acrylic polish. Remove all internal and external dust and other dirt and treat all surfaces with an anti-static polish on completion.
g. Provide Owner with complete cleaning instructions recommended by acrylic manufacturer for safe cleaning of acrylic sheets.

2. ACRYLIC SHEET, NON-GLARE

a. Non-glare acrylic sheet shall be premium quality such as manufactured by Rohm and Haas, Du Pont, American Cyanamid or approved equal.

3. ALUMINUM

a. Aluminum extrusions shall be ASTM B209, 6063-TS alloy, shop primed. Extrusions shall be of best quality with no die lines or other imperfections.
b. Aluminum sheet and plate shall be ASTM B209, 3003 alloy, shop primed. Sheet and plate shall be of best architectural quality; stretcher leveled and visually flat.
c. Aluminum Castings: Provide aluminum castings of alloy and temper recommended by the aluminum producer and finisher for the casting process used and for the use and finish indicated.
d. Anodized Aluminum: Provide Mill 5005 alloy (anodized quality) aluminum with clear, anodized coating of .2 mil. th.

4. GLASS

a. Glass shall be fully tempered and color of glass is to be consistent for all requirements as defined in Contract Documents, unless otherwise noted.\

5. PHOTOPOLYMER

a. Photopolymer: Provide sheet photopolymer Nova Polymers Inc. NovAcryl PT Series PT-236 or approved equal, in size and type specified in Sign Program bid documents.
b. Aluminum-Backed Photopolymer: Provide sheet photopolymer Jet USA Corp. LS1-175-AB Alum. or approved equal, in size and type specified in Sign Program bid documents.
c. Provide moisture resistant polyamide nylon or exterior grade photopolymer resin with minimum face relief of .032" and maximum face of .040" in compliance with ADA regulations and specifications. Photopolymer material to be of single piece construction using only clear, recyclable PETG or cellulose-based phenolic in specified base thickness. Laminated photopolymers are not acceptable.
d. Process to factory specifications to be approved methods, equipment, and fabrication techniques. Use only computer generated, professional grade film. Vellum film is not acceptable. Matthews or Carbit automotive grade acrylic polyurethane finishes to be used. Lacquer-based finishes are not acceptable.

6. STAINLESS STEEL

a. Stainless Steel Plate, Sheet and Strip: Provide stainless steel plate, sheet, or strip, ANSI Type 316, complying with the requirements of ASTM A 167. The finish for all Stainless Steel is to be No. 4, except where specifically noted.

7. DIGITAL HIGH-PRESSURE LAMINATE

a. Provide exterior grade high pressure plastic laminate as manufactured by IZone, 2526 Charter Oak Drive, Suite 100, Temple, Texas, 76502, U.S.A. 888.464.9663. Finish and color combination to match selection from manufacturer's standards.\
b. on-ferrous metal or galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance and to prevent staining of surrounding surfaces.

8. FASTENERS AND HARDWARE

a. All exposed screws shall be countersunk, unless otherwise noted.

9. ADHESIVES

a. Adhesives required in fabrication and installation shall be compatible with the materials to be laminated or adhered.
b. Adhesives shall be used in accordance with the recommendations of the manufacturer of the adhesives and the material to be laminated or adhered.
c. Surfaces on which adhesives are to be applied shall be smooth, clean and free of dust, dirt, grease, fingerprints or other foreign matter.
d. Adhesives shall be guaranteed not to deteriorate, discolor, delaminate or fail in adhesion for any reason including exposure to heat, sunlight, weathering or other environmental conditions.
e. Adhesives shall not change the color of, or in any way deteriorate, the materials to which they are being applied.
f. Visible joints shall be even and free from air bubbles and other defects.
g. Adhesive foam mounting tapes for permanent installation shall be premium quality double-coated acrylic foam tape such as manufactured by 3M (VHB Tape) or approved equal. Urethane foam tapes will not be allowed.

h. Unless otherwise indicated, when used for permanent installation, adhesive foam mounting tape shall be 1/2" wide and 1/16" thick. Coverage shall be at least one continuous strip of tape at four inch intervals. No tape shall be closer than 1/2" from the edge of any component.
i. Silicone adhesives shall be clear, ready-to-use, high performance, premium quality materials, such as manufactured by General Electric (GE 1200), or approved equal.
j. Epoxy adhesives shall be two-component, thermal-setting, premium quality materials such as manufactured by Devcon (Two-Ton Epoxy), or approved equal.

10. PAINT, INK AND VARNISHES

a. All colors shall be exactly reproduced as specified and shall match submitted samples.
b. Paint Manufacturer: Duron Paints and Wall Coverings, Matthews Paint Company, or approved equal.
c. All paint shall be applied using a high pressure spray in dust-free conditions and shall be allowed to dry or cure properly before being moved.
d. Painted surfaces and other applied finishes shall have a smooth, even finish and be free of imperfections, marks, scratches, embedded dirt, wave patterns or other irregularities.
e. Paint required in fabrication, including paint for lettering, screened copy, subsurface copy, etc. shall be compatible with the materials to which it is applied and shall be guaranteed not to cause discoloration, deterioration or de-lamination for any reason, including exposure to heat, sunlight, weathering or other environmental conditions.
f. Paints shall be precisely identified on the shop drawings and submitted samples.
g. Prime coats or other surface pre-treatments, where recommended by the manufacturer of the paint, shall be included in the work.

11. FINISHES

a. Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures or other characteristics related to appearance, provide color matches indicated, or if not indicated, as selected by the Owner.
b. Metal: Comply with NAAMM "Metal Finishes Manual" for finish designations and applications recommendations. All finishes are to be measured by Sign Contractor with a Glossimeter to assure reasonable compliance with the Americans with Disabilities Act, 1992.
c. Glass: Non-glare
d. Aluminum: Anodized, Powder-coated
e. Paint: Satin

12. ETCHED GLASS/ACRYLIC

a. Graphics shall be etched evenly into the glass by a high pressure spray of sand, carborundum grit, or metal bead to the depth specified in Contract Documents.
b. Protect all adjacent surfaces from over spray.
c. Rubber friskets are to be used only for flat surfaces and are to be used only once per sign.

13. SILK SCREEN

a. Silk screens shall be made using photographic film positives. Hand-cut positives may not be used except in exceptional circumstances and only with the Owner's

prior approval in writing. If hand-cut positives are allowed, they shall be of equivalent quality to photographic film.

b. Ink finish shall be non-glare, 'eggshell' or semi-matte, unless otherwise specified.

14. STENCIL-CUT GRAPHICS, INFILL CHARACTERS

a. Glass/Acrylic infill characters shall be individually cut from glass/acrylic sheet with a roused shoulder cut to nest against the stencil-cut opening or shall be cut from acrylic sheet and solvent-fused to a diffuser back-up panel.

b. For exterior applications, all infill characters shall be bonded to the stencil-cut surface with a continuous bead of silicone to assure a weather tight seal.

c. Provide required space between stencil-cut edge and any infill characters to compensate for temperature expansion and contraction.

15. DIMENSIONAL LETTERS AND NUMBERS

a. Letters and Numbers: Fabricated and laser-cut letters/numbers. Comply with requirements indicated for finish, style, and size.

b. Metal: Aluminum, as indicated on drawings.

c. Acrylic: as indicated on drawings.

16. APPLIED COPY

a. Die-cut copy characters from vinyl film with pressure-sensitive adhesive backing. Apply copy to the exposed face of the sign panel or other surface as specifically noted.

17. VINYL

a. Non-reflective film: Provide opaque, non-reflective vinyl film with repositionable adhesive backing. Adhesive shall be positionable and pressure activated.

b. Minimum application temperature to be 40° F (4° C). Maximum application temperature to be 100° F (38° C). When applied in accordance with manufacturers recommended procedures, the film is to have an exterior exposure life of 7 years.

c. Properties:

1) Thickness .003" - .004"
2) Tensile strength: 5 lbs./in. at 73° F
3) Dimensional stability: 1/64"
4) Temperature Range: -40° F to +200° F
5) Resistance: no effect at -73° F and 40° F
6) Adhesion to etched aluminum: 7.0 lbs/in.

d. Vinyl Film: Provide opaque non-reflective vinyl film, 0.0035" minimum thickness, with pressure sensitive adhesive backing, suitable for exterior as well as interior applications.

18. REMOVABLEREFLECTIVEFILM

a. Provide adhesive coated, opaque, reflective vinyl film with easy release liner intended for production of removable messages. This sheeting to remain totally reflective even when wet by rain.

b. Properties:

1) Observation angle: .2° to .5°

2) Entrance angle: -4/35° to 18/40° 7 to 4.5
3) Thickness: .010”
4) Dimensional stability: .010”
5) Applied temperature: -30° F to +200° F
6) Flexibility: no cracking
7) Removability: up to 18 months
8) Adhesion on etched aluminum: 2.5 lbs/in.

19. NON-REMOVABLEREFLECTIVEFILM

a. Provide adhesive coated, opaque, non-reflective vinyl film with strong permanent adhesion.
b. Properties:

1) Observation angle: .2° to .5°/40° 7 to 4.5
2) Thickness: .010”
3) Dimensional stability: .010”
4) Applied temperature: -30° F to +200° F
5) Flexibility: no cracking
6) Removability: up to 18 months
7) Adhesion on etched aluminum: 2.5 lbs/in.

20. PINMOUNTS

a. Pin mounts shall be fabricated from threaded studs permanently fixed to the component to be mounted. All studs shall be square to the face of the component
b. Epoxied or welded studs shall be fabricated with no distortion or discoloration of the face of the component or any other exposed surfaces.
c. Holes drilled into plastic or wood cut component shall be fabricated with no distortion or other visible effect on face or other exposed surfaces.
d. There shall be a minimum of four studs on plaques, two studs on individual typographic characters and one stud on punctuation marks.
e. Silicone adhesive shall be used to install pin mounts in walls or other supporting surfaces. Receiving hole shall be of sufficient size to allow positioning, and shall have clean edges and neat appearance.
f. Support components with foam tape or other mechanical means that does not damage surrounding surfaces, until permanent adhesives are set.

21. ATTACHMENTS

a. Wall Mounted Panel Signs: Attach panel signs to wall surfaces using the methods indicated below and as specified by manufacturer:
b. Vinyl-Tape Mounting: Use double-sided foam tape, of thickness indicated, to mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
c. Silicone-Adhesive Mounting: Use liquid silicone adhesive recommended by the sign manufacturer to attach sign units to irregular, porous, or vinyl-covered surfaces.
d. Use double-sided vinyl tape where recommended by the sign manufacturer to hold the sign in place until the adhesive has fully cured.
e. Mechanical and Shim Plate Mounting: Provide concealed aluminum shim plates 1/8” thick, with pre-drilled and countersunk holes, at locations indicated and where other mounting methods are not practicable. Attach the plate with fasteners and anchors suitable for secure attachment to the substrate. Attach panel sign units to the plate using the method specified above.

f. Bracket-Mounted Units: Provide the manufacturer's standard brackets, fittings, and hardware as appropriate for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls or ceilings with concealed fasteners and anchoring devices to comply with manufacturer's directions.

g. Dimensional Letters, Numbers, and Panels: Mount letters, numbers, and panels using standard fastening methods recommended by the manufacturer, or custom methods as indicated, for letterform or panel type mounting, wall construction, and conditions of exposure indicated. Provide heavy paper template to establish letter spacing and to locate holes for fasteners.

h. Flush Mounting: Mount letters with backs in contact with the wall surface.

i. Projected Mounting: Mount letter at the indicated projection distance from the wall surface.

j. Direct Applications: Provide silk-screened or frisket painted signs over coated panels with clear, non-yellowing protective coating. The manufacturer has the option of selecting either process indicated above.

22. CONCRETEFOOTINGS

a. Sign Contractor shall provide shop drawings and engineering calculations prepared and sealed by a registered professional engineer, licensed in project jurisdiction. Formwork design/engineer qualifications shall be under direct supervision of a register professional engineer, licensed in project jurisdiction.

b. Regulatory requirements shall conform to local laws, codes, and regulations. Sign Contractor shall submit formwork drawings, calculations, and other data to local authorities as they may require.

c. Typical formwork shall be plywood, metal, or other panel-type materials providing continuous smooth surfaces, non-reactive with form release agent or water. Formwork shall be furnished in largest practicable sizes to minimize number of joints. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection. Conform to joint system indicated on drawings or accepted shop drawings.

d. Form ties shall be factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spilling of concrete upon removal. Sign Contractor shall provide ties that will leave no metal closer than 37mm (1 - 1/2") from face of exposed concrete surface, and, when removed, will leave holes not larger than 25mm (1") diameter in concrete surfaces.

e. Form release agent shall be colorless material, with maximum volatile organic compounds (VOCs) of 350 gm per liter; non-staining; which will not bond with or adversely affect concrete surfaces and which will be compatible with subsequent treatments of concrete surfaces.

f. Fabricate formwork to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide back-up material at joints. Minimize joints. Provide removable panels at bottom of column, pier, wall, and other forms where necessary to facilitate cleaning and inspection. Fabricate forms for easy removal without hammering or prying against concrete surfaces.

g. Install forms in accordance with ACI 301, except for more stringent requirements of specifications or the formwork design engineer. Brace formwork to ensure stability.

h. Tolerances, unless otherwise indicated, shall conform to requirements of ACI 117. Irregularities in formed surfaces shall conform to requirements of ACI 347, as follows:

1) Class A: For concrete surfaces exposed to view.
2) Class C: For other concrete surfaces

i. Sign Contractor shall provide formed concrete, and concrete slab edges, that are maximum +/- 12mm (1/2") from designated design plane in any location.

j. Application of form release agent shall be applied in accordance with manufacturer's instructions. Apply prior to placing reinforcing steel, anchoring devices, and embedded items. Do not apply where concrete surfaces are scheduled to receive finishes, which may be affected by agent. Soak surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

k. Inserts, embedded items, and openings shall be provided with formed openings where required for work embedded in or passing through concrete.

l. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

m. Adjustments to formwork shall be checked before placing reinforcements and continuously during concrete placement to verify that work will be within specified tolerances. Conform to requirements of ACI 347. Correct excessive settlement or distortion of forms during concrete placement. Retighten forms during concrete placement if required to eliminate mortar leaks.

n. Form removal shall occur after concrete has sufficient strength to support its own weight and construction, design, or other loads that may be imposed upon it. Remove formwork that does not support loads when the following conditions are met:

1) Concrete has cumulatively cured at not less than 10°C (50°F) for 24 hours.
2) Concrete is sufficiently hard that form removal will not damage it. Curing and protection operations are maintained. Remove formwork supporting loads when concrete has attained stripping strength specified by formwork designer. Do not remove formwork until slab finishing tolerances have been measured. Remove formwork progressively so no unbalanced loads are imposed on structure. Do not damage concrete surfaces during form removal.

o. Clean forms to remove foreign matter as erection proceeds. Use compressed air to remove foreign matter. Ensure that water and debris drain to exterior through clean-out ports. During cold weather, remove ice and snow from forms. Do not use deicing salts. Do not use water to clean out completed forms unless formwork and construction proceed within heated enclosure.

PART 3 - EXECUTION

3.1 GRAPHICS/DRAWINGS

A. GENERAL REQUIREMENTS

1. Drawings are for concept only. Sign Contractor shall be responsible for providing a product which meets the requirements of both the specifications and the drawings, and which works effectively, efficiently and safely.
2. Written dimensions on the Drawings shall take precedence over scaled dimensions. Sign Contractor shall be responsible for all dimensioning and must notify Owner of any discrepancies, to await clarification, prior to proceeding
3. Failure to request clarification of any inadequacy, omission or conflict will not relieve the Contractor of responsibility.

B. BRAILLE

1. Provide all Grade 2 Braille translations, as required to conform to American National Standards ICC/ANSI A117.1, 2003, as referenced in section 1.10.

3.2 FABRICATION

A. Field measure all conditions prior to fabrication.

B. All work shall be constructed as complete systems, including all stiffeners, fasteners, welding, sealants, jointing, miscellaneous pieces and material thicknesses, etc.

C. Confer with the Owner regarding all critical items before shop drawings are started, and advise the Owner of any significant discrepancies in field measurements or operational difficulties prior to fabrication. Obtain the Owner's written approval for any resulting deviations from the specifications and/or drawings that may become necessary.

D. Work shall be performed by competent workmen and shall be of the best quality, free from defects impairing strength, durability and appearance. All items shall be made of new materials.

E. Connections, angles, shapes and details are for intent only and are to be sized, reinforced and detailed as required for their particular application. Details not shown are to be at least equal in quality to those detailed.

F. Methods of fabrication, joining, finishing and installation of all components and work shall be according to the manufacturer's instructions for the use of any products, materials, fittings and equipment used in their construction.

G. All details of construction are to be engineered with appropriate strength materials and finished to withstand the potential rigors of their installed locations.

H. Installed work shall be accurately reproduced from the artwork. Characters with rounded positive or negative corners, nicked, cut or ragged edges, etc., will not be accepted.

I. All work shall be uniform in detail design and finish.

3.3 INSTALLATION

A. General: Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions. For signs installed at exterior locations, include all elements recommended by manufacturers and good practice to insure weatherproofing for internal and external parts and materials.

B. Install the work in a well organized and timely manner. Whenever possible, the work shall be installed as one continuous activity. The installation process shall be coordinated to accommodate the needs of the Owner.

C. Inform Owner, at least two weeks in advance, of any intended installation and arrange, at the Owner's convenience to have all patterns in place, and initial signs of each type ready for installation and approval by the Owner on site before proceeding with the rest of the installation. It is important that such approval processes be organized efficiently so that approvals can take place in a timely manner.

D. Sign locations detailed in Contract Documents are estimated. Sign Contractor shall be responsible for confirming all locations in field based on direction in Contract Documents. Where variances occur from Documents or conditions are not as anticipated, Sign Contractor to notify Owner immediately, and await direction prior to proceeding.

E. Follow recommendations and instructions for installation as provided by component manufacturers. Notify the Owner in writing if such installation will not provide permanent, rigid installation within site conditions.

F. No installation procedures or materials shall be used that will in any way change the visual quality or in any manner have an adverse effect on adjacent materials and surfaces.

G. Protect all adjacent surfaces from damage during installation. Restore or replace any damaged surfaces to original condition and appearance.

H. Install all signs at the locations and heights specified in the Contract Documents. All signs shall be installed level, plumb, and perpendicular to the surface upon which they are mounted, unless otherwise specified.

I. Coordinate all scheduling and installation procedures with the Owner, General Contractor and others to avoid delays or additional costs.

J. Where appropriate, notify Owner in writing of any visual or physical conflicts, to await clarification, prior to proceeding

K. All work shall be provided with suitable protective coverings during shipment and installation. Remove and replace protective coating for inspection when requested. Final removal of protective coatings shall take place only when there is no danger of damage from further work, and all protective coatings shall be removed simultaneously from similarly finished items to prevent uneven oxidation or discoloration.

3.4 CLEANINGAND PROTECTION

A. Remove packing and construction materials from the site. Leave premises broom clean and ready for work under other contracts or ready for use Vacuum any carpets and spot clean where if necessary.

END OF SECTION 101400

SECTION 102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-polymer toilet compartments configured as toilet enclosures and urinal screens.

B. Related Sections:

1. Division 06 Section “Miscellaneous Rough Carpentry" for blocking.
2. Division 10 Section "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.

1. Show locations of cutouts for compartment-mounted toilet accessories.
2. Show locations of reinforcements for compartment-mounted grab bars.
3. Show locations of centerlines of toilet fixtures.

C. Samples for Initial Selection: For each type of unit indicated. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:

1. Each type of material, color, and finish required for units, prepared on 6-inch-square Samples of same thickness and material indicated for Work.
2. Each type of hardware and accessory.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of toilet compartment, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Comply with requirements in GSA's CID-A-A-60003, "Partitions, Toilets, Complete."

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and COMAR for toilet compartments designated as accessible.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.

B. Stainless-Steel Castings: ASTM A 743/A 743M.

2.2 SOLID-POLYMER UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Comtec Industries/Capitol Partitions.
2. Knickerbocker Partition Corporation.
3. Rockville Partitions Incorporated.

B. Toilet-Enclosure Style: Floor anchored.

C. Urinal-Screen Style: Wall hung.

D. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.

1. Integral Hinges: Configure doors and pilasters to receive integral hinges.

2. Heat-Sink Strip: Manufacturer's standard continuous, stainless-steel strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
3. Color and Pattern: One color and pattern in each room as selected by Architect from manufacturer's full range.

E. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.

F. Brackets (Fittings):

1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.

1. Material: Stainless steel.
2. Hinges: Manufacturer's standard integral hinge for solid-polymer doors.
3. Latch and Keeper: Manufacturer's standard recessed latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.4 FABRICATION

A. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

B. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

   a. Pilasters and Panels: 1/2 inch.
   b. Panels and Walls: 1 inch.

B. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113

SECTION 102123 – ROOM DARKENING CUBICLE CURTAIN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes room darkening cubicle curtain, track, valence, and hardware.

B. Related Sections include the following:

1. Section 061053 “Miscellaneous Rough Carpentry” for blocking for mounting items requiring anchorage.
2. Section 095113 “Acoustical Panel Ceilings” for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.

1.3 PERFORMANCE REQUIREMENTS

A. Provide cubicle curtains, track and hardware from a firm that has specialized in the fabrication and installation of such work for at least five (5) years in projects of similar size and scope.

B. Installation shall be performed by an authorized manufacturer's representative experienced in the installation and maintenance of such assemblies.

1.4 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for room darkening cubicle curtains, track, and accessories.

1. Include durability, fade resistance, and fire-test response characteristics for each type of curtain fabric indicated.

B. Shop Drawings: Submit drawings showing lay-out and type of cubicles, sizes of curtains, number of carriers, anchorage details and conditions requiring accessories. Indicate dimensions taken from field measurements.

1. Include details on blocking above ceiling and in walls.

C. Samples: Submit 24 x 24-in. samples of fabrics(s) as specified and operable hardware with cut sheets.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Instructions: Submit manufacturer's printed instructions for cleaning and maintenance of the products.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain room darkening cubicle curtains, track, and accessories through one source from a single manufacturer.

1. Provide cubicle curtains, track and hardware as complete units produced by a single manufacturer, including the necessary mounting brackets, hardware, fittings, fastenings, and installation.

1.7 PROJECT CONDITIONS

A. Subcontractor shall not install cubicles until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where cubicles are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication schedule with construction progress to avoid delaying the Work..

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AR Nelson Co.
2. Construction Specialties, Inc.
3. Imperial Fastener Company
4. Quality Srage Drapery, Inc.

2.2 MATERIALS

A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15.

B. Extruded Aluminum: ASTM B 221, Alloy 6063-T4, or –T5 as standard with manufacturer.

2.3 CUBICLE TRACK

A. General: Provide manufacturer's standard surface-mounted track of heavy extruded aluminum alloy, 1 3/8" x 3/4", complete with accessories and components required for complete and secure installation, including splices, end caps and corner bends.

1. Provide spacers as required for flush mounting in tegular ceiling applications.
2. Corner Bends: Shall have a 18" radius fabricated in one continuous piece.

B. Finish: Powder coat white.

2.4 ROOM DARKENING FABRIC

A. Provide 100% inherently flame resistant polyester fabric, solid weave black room darkening fabric with heavy tape at bottom.

1. 98% room darkening capability.
2. Double needled lock-stitched top, side and bottom hems, 1-1/2” wide.
3. Provide continuous Velcro material sewn to sides of curtain at Ends and meeting edges and applied to walls for closure.

B. Width equal to track length from which curtain is hung plus 10 percent added fullness, but not less then 12 inches added fullness.

C. Length equal to floor-to-ceiling height.

D. Provide minimum 10” high valence attached to outside face of track of same material as curtain.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with installer present, for compliance with requirements for installation tolerance, and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. INSTALLATION

1. General: Install tracks level and plumb, according to manufacturer’s written instructions.

   a. Curtain Track Mounting: Surface.

2. Track Accessories: Install splices, end caps, connectors, end stops, snap outs, and other accessories as required for a secure and operational installation.
3. Curtain Carrier: Provide curtain carrier adequate for 6 inch spacing along full length of curtain.
4. Curtains: Hang curtains on each curtain track. Secure with curtain tieback.

END OF SECTION 102123

SECTION 102238 - OPERABLE PANEL PARTITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Manually operated, acoustical panel partitions.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
2. Section 064216 “Flush Wood Paneling” for wall paneling to be used for customer furnished facing material.
3. Section 092900 "Gypsum Board" for fire-rated assemblies and sound barrier construction above the ceiling at track.

1.3 DEFINITIONS

A. STC: Sound Transmission Class.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Certificates for Credit MR 7: Chain-of-custody certificates certifying that operable panel partitions comply with forest certification and chain-of-custody requirements. Include statement indicating cost for each certified wood product.
3. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that products contain no urea formaldehyde.
4. Laboratory Test Reports for Credit IEQ 4.4: For composite wood products used in operable panel partitions, documentation indicating that products comply with the testing

and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For operable panel partitions.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.

D. Samples for Initial Selection: For each type of exposed material, finish, covering, or facing.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of exposed material, finish, covering, or facing, prepared on Samples of size indicated below:

1. Panel Facing Material: Manufacturer's standard-size unit, not less than 3 inches square.
2. Panel Edge Material: Not less than 3 inches long.
3. Hardware: One of each exposed door-operating device.

F. Delegated-Design Submittal: For operable panel partitions.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Partition track, track supports and bracing, switches, turning space, and storage layout.
2. Suspended ceiling components.
3. Structural members to which suspension systems are attached.
4. Plenum acoustical barriers.

B. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.

C. Qualification Data: For qualified Installer.

D. Product Certificates: For each type of operable panel partition.

1. Include approval letter signed by manufacturer acknowledging customer-furnished panel facing material complies with requirements.

E. Product Test Reports: For each operable panel partition, for tests performed by a qualified testing agency.

F. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For operable panel partitions to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Seals, hardware, track, track switches, carriers, and other operating components.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Faulty operation of operable panel partitions.
    b. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design track supports from structure above.

B. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:

1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, and rated for not less than the STC indicated.

C. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

2.2 OPERABLE ACOUSTICAL PANELS

A. Operable Acoustical Panels: Partition system, including panels, seals, finish facing, suspension system, operators, and accessories.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Hufcor, Inc.
b. Modernfold, Inc.; a DORMA Group company.
c. Panelfold Inc.

B. Panel Operation: Manually operated, individual panels.

C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.

D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.

1. Panel Width: As indicated.

E. STC: Not less than 50.

F. Panel Thickness: Not less than 3 inches.

G. Panel Materials:

1. Certified Wood: Wood for operable panel partitions shall be certified as "FSC Pure" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."
2. Recycled Content of Operable Panel Partitions:

a. Recycled Content of Steel: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent by weight.

3. Steel Frame: Steel sheet, manufacturer's standard nominal minimum thickness for uncoated steel.

4. Skin/Face Sheets - Medium-Density Fiberboard: ANSI A208.2, made with binder containing no urea formaldehyde.

H. Panel Closure: Manufacturer's standard unless otherwise indicated.

I. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.

1. Hinges: Concealed (invisible).

2.3 SEALS

A. General: Provide seals that produce operable panel partitions complying with performance requirements and the following:

1. Manufacturer's standard seals unless otherwise indicated.
2. Seals made from materials and in profiles that minimize sound leakage.
3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.

B. Vertical Seals: Deep-nesting, interlocking steel astragals mounted on each edge of panel, with continuous PVC acoustical seal.

C. Horizontal Top Seals: Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track.

D. Horizontal Bottom Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.

1. Automatically Operated for Acoustical Panels: Extension and retraction of bottom seal automatically operated by movement of partition, with operating range not less than 1-1/2 inches between retracted seal and floor finish.

2.4 PANEL FINISH FACINGS

A. General: Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.

B. Medium Density Fiberboard (MDF) Panel Faces: Provide MDF face panels with manufacturer’s standard paint grade veneer. Panels to be field painted under Division 09 “Interior Painting” specification.

C. Customer-Furnished Facing Material: Wood veneer on 1/2 inch thick MDF wall panels furnished under Section 064216 “Flush Wood Paneling” to be field installed over face of operable panels to the height indicated. Coordinate with wood veneer panel supplier for panel width, relationship to operable panel frames and panel-to-panel joints, and for location of blocking in the operable panel for attachment of wood veneer panels.

D. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.5 SUSPENSION SYSTEMS

A. Tracks: Steel with adjustable steel hanger rods for overhead support, designed for operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.

B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.

1. Multidirectional Carriers: Capable of negotiating intersections without track switches.

C. Track Intersections, Switches, and Accessories: As required for operation, storage, track configuration, and layout indicated for operable panel partitions and compatible with partition assembly specified. Fabricate track intersections and switches from steel.

1. Include center carrier stop.

D. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with ASTM E 557 except as otherwise required by operable panel partition manufacturer's written installation instructions.

B. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.

C. Install panels from marked packages in numbered sequence indicated on Shop Drawings.

D. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

E. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

F. Light-Leakage Test: Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids. Adjust partitions for alignment and full closure of vertical joints and full closure along top and bottom seals.

3.3 ADJUSTING

A. Adjust operable panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.

B. Verify that safety devices are properly functioning.

3.4 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operable-partition operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

END OF SECTION 102238

SECTION 102600 - WALL PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Corner guards.

B. Related Sections:

1. Division 08 Section "Door Hardware" for kick, mop, and push plates.

1.3 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.

C. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Initial Selection: For each type of impact-resistant wall protection unit indicated.

1. Include similar Samples of accent strips and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Corner Guards: 12 inches long. Include examples of joinery, corners, and field splices.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.

1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.

1.6 MATERIALS MAINTENANCE SUBMITTALS

1. Include mounting and accessory components. Replacement materials shall be from same production run as installed units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated. Refer to Division 01 Section "Quality Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and COMAR.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
2. Keep plastic sheet material out of direct sunlight.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F for not less than 72 hours before beginning installation and for the remainder of the construction period.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Deterioration of plastic and other materials beyond normal use.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless-Steel Sheet: ASTM A 240/A 240M.

B. Fasteners: Stainless-steel screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

C. Adhesive: As recommended by impact-resistant plastic wall protection manufacturer and with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 CORNER GUARDS

A. Flush-Mounted, Metal Corner Guards: Fabricated from one-piece, formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Arden Architectural Specialties, Inc.
b. IPC Door and Wall Protection Systems; Division of InPro Corporation.

2. Material: Stainless steel, Type 430.

a. Thickness: Minimum 0.0625 inch.
b. Finish: Directional satin, No. 4.

3. Wing Size: Nominal 2 by 2 inches.
4. Corner Radius: 1/8 inch.
5. Height: 6’-10”, to be mounted at 4” above finish floor.
6. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes to be mounted before the final layer of drywall.
7. Provide j-mold edge at abutting drywall at sides & top of corner guard.

2.3 END-WALL GUARDS

A. Flush-Mounted, Metal, End-Wall Guards: Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Arden Architectural Specialties, Inc.
   b. IPC Door and Wall Protection Systems; Division of InPro Corporation.

2. Material: Stainless steel, Type 430.

   a. Thickness: Minimum 0.0625 inch.
   b. Finish: Directional satin, No. 4.

3. Wing Size: Nominal 2 by 2 inches.
4. Corner Radius: 1/8 inch.
5. Height: 6'-10", to be mounted at 4" above finish floor.
6. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes to be mounted before the final layer of drywall.
7. Provide j-mold edge at abutting drywall at sides & top of corner guard.

2.4 FABRICATION

A. Fabricate impact-resistant wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.

B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

C. Fabricate corner guards without seams or joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections.

2.5 METAL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Remove tool and die marks and stretch lines, or blend into finish.
2. Grind and polish surfaces to produce uniform finish, free of cross scratches.
3. Run grain of directional finishes with long dimension of each piece.
4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of work.

B. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

1. For impact-resistant wall protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

1. Install impact-resistant wall protection units in locations and at mounting heights indicated on Drawings.

a. Provide mounting hardware, anchors, and other accessories required for a complete installation.
b. Provide anchoring devices to withstand imposed loads.

3.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Underlavatory guards.
3. Custodial accessories.

B. Related Sections:

1. Division 08 Section "Mirrors" for frameless mirrors.
2. Division 09 Section "Tiling" for ceramic toilet and bath accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for Project.
5. Manufacturer's warranty.

B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify products using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.8 WARRANTY

A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.

B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.

C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.

D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.

E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

I. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:

1. Manufacturer: Subject to compliance with requirements, provide products by the following:
   a. American Specialties, Inc.

2. Product: Surface Mounted Twin Hide-A-Roll Toilet Tissue Dispenser, Model No. 0030.
3. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
4. Mounting: Surface mounted.
5. Capacity: Designed for two (2) standard or two (2) 5-1/4 inch diameter tissue rolls.
6. Material and Finish: Stainless steel, No. 4 finish (satin).

B. Paper Towel (Roll) Dispenser :

1. Manufacturer: Subject to compliance with requirements, provide products by the following:
   a. Kimberly-Clark , Inc.

2. Product: In-Sight* Sanitouch* Hard Roll Towel Dispenser, Product Code: 09990
3. Description: No touch dispensing system automatically advances and cuts towel when activated by pulling exposed towel.
4. Mounting: Surface mounted.
5. Minimum Capacity: 8-inch- diameter roll, 1.5” hub.
6. Material and Finish: ABS plastic, smoke gray.
7. Lockset: Key activated spring lock.

C. Liquid Soap Dispenser:

1. Manufacturer: Subject to compliance with requirements, provide products by the following:
   a. Spartan Chemical Company, Inc.

2. Product: Lite’n Foamy Dispenser, Model No. 9754.
3. Description: Designed for dispensing soap in lather form.
4. Mounting: Vertically oriented, surface mounted.
5. Capacity: 34 oz.
6. Materials and Finish: ABS Plastic, color: Black.
7. Lockset: Keyed Access.
8. Refill Indicator: Window type.

D. Grab Bar:

1. Mounting: Flanges with concealed fasteners.
2. Material: Stainless steel, 0.05 inch thick.

   a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.

3. Outside Diameter: 1-1/2 inches.
4. Configuration and Length: As indicated on Drawings.

E. Sanitary-Napkin Disposal Unit:

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. American Specialties, Inc.

2. Product: Recess Mounted Sanitary Napkin Disposal, Model No. 6471.
3. Description: Full face door fabricated of 18 gauge stainless steel alloy 18-8, type 304 attached to the cabinet body with a concealed 3/16" diameter stainless steel multi-staked piano hinge. Body and push-door shall be 20 gauge stainless steel with no exposed fastening devices or spot welded seams. Push door shall be hung on a full width concealed 3/16" diameter stainless steel multi-staked piano hinge and shall be held closed with a flat spring mounted in cabinet top and shall have the international graphic symbol for waste on face. Waste receptacle shall be fabricated of stainless steel and shall have a handle for easy servicing and removal and fully hemmed edges all around top opening for user and service safety.
4. Mounting: Surface mounted.
5. Capacity: Waste capacity of 1.4 gal.
6. Lockset: Tumbler lock with keyed Access.
7. Material and Finish: All exposed surfaces of unit shall have a No 4 satin finish, and shall be protected during shipment by PVC film easily removable after installation.

F. Seat-Cover Dispenser:

1. Manufacturer: Subject to compliance with requirements, provide products by the following:
   a. American Specialties, Inc.

2. Product: Recessed Toilet Seat Cover Dispenser, Model No. 6477.
3. Cabinet, frame and door fabricated of alloy 18-8 stainless steel, type 304. Cabinet shall be No20 gauge with a 122 wide perimeter return to lay flat against wall or partition. Door shall be fabricated of 18 gauge with a 1/222 square return to wall with no open seams visible on door face. Door shall be attached to top of cabinet with a full length 3/1622 (5mm) dia. stainless steel multi-staked piano hinge and shall be held closed with a tumbler lock keyed alike to other ASI washroom equipment. Cover dispensing slot shall have a fully deburred flat edge for snag –free dispensing and user safety. Structural assembly of cabinet and door components shall be of welded construction and shall have no exposed fasteners or welded seams.
4. Capacity: 500 standard single or half-fold paper toilet seat covers
5. Lockset: Tumbler lock with keyed Access.
6. Material and Finish: All exposed surfaces of unit shall have a No 4 satin finish, and shall be protected during shipment by PVC film easily removable after installation.

2.3 UNDERLAVATORY GUARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Plumberex Specialty Products, Inc.
2. Truebro by IPS Corporation.

B. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings. Comply with ADAG requirements.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.4 CUSTODIAL ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Specialties, Inc.
2. Bobrick Washroom Equipment, Inc.
3. Bradley Corporation.

B. Utility Shelf/Mop and Broom Holder:

1. Basis of Design Product: Utility Shelf with Mop Holders, Drying Rod and Rag Hooks, Model No. 1315.
2. Utility Shelf with Mop Holders, Drying Rod and Rag Hooks shall be fabricated of 18 gauge alloy 18-8 stainless steel, type 304. Utility shelf shall have 2-1/2" (65mm) wide hemmed-in edge all around. Rubber-cam mop-holders shall be provided at the face of shelf. Mop holder brackets shall be fabricated of cadmium plated steel and shall be ribbed for rigidity. Each mop holder shall have a pivoting spring loaded serrated rubber cam that shall hold round handles of 7/8" to 1-1/4" diameter wedged against ribbed clamp plate. A 3/8" diameter stainless steel drying rod shall be provided to run between the mounting bracket gussets. Mounting brackets shall be 16 gauge.
3. Capacity: 4 mop holders/3 rag hooks
4. Length: 36inches.
5. Material and Finish: All exposed surfaces of unit shall have a No 4 satin finish, and shall be protected during shipment by PVC film easily removable after installation.

2.5 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 102800

SECTION 104413 - FIRE EXTINGUISHER AND AED CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire protection cabinets for the following:

a. Portable fire extinguishers.
b. Fire hose valves.

B. Related Sections:

1. Division 10 Section "Fire Extinguishers."

1.3 DEFINITIONS

A. AED: Automatic External Defibrillator.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.

1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
2. Show location of knockouts for hose valves.

B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For each type of fire protection cabinet indicated.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Size: 6 by 6 inches square.

E. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 COORDINATION

A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.

C. Coordinate sizes and locations of fire protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FIRE PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher or hose valve.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. J. L. Industries, Inc., a division of Activar Construction Products Group; Embassy Series.
b. Larsen's Manufacturing Company; Occult Series.
c. Potter Roemer LLC; Dana Series.

B. Cabinet Construction: Nonrated, 1-hour fire rated, or 2-hour fire rated as indicated.

1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material. Provide factory-drilled mounting holes.
2. Provide cabinets with rating equal to the rating of the wall containing the cabinet.

C. Cabinet Material: Steel sheet.

1. Shelf: Same metal and finish as cabinet.

D. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.

E. Cabinet Trim Material: Steel sheet.

F. Door Material: Steel sheet.

G. Door Style: Vertical duo panel , concealed hinges and frame.

H. Door Glazing: Tempered float glass (clear).

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide recessed door pull and friction latch.
2. Provide concealed hinge permitting door to open 180 degrees.

J. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.

a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."

1) Location: Applied to cabinet door.
2) Application Process: Pressure-sensitive vinyl letters.
3) Lettering Color: Red.
4) Orientation: Vertical.

K. Finishes:

1. Manufacturer's standard baked-enamel paint for the following:

a. Exterior of cabinet door except for those surfaces indicated to receive another finish.
b. Interior of cabinet and door.

2.3 AED CABINET

A. Cabinet Type: Standard size recessed wall cabinet suitable for Automatic External Defibrillator.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. J. L. Industries, Inc., a division of Activar Construction Products Group; Embassy Series.

b. Lifeguard Medical Solutions.
c. Koninklijke Philips Electronics N.V.

B. Cabinet Material: Steel sheet.

C. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.

D. Cabinet Trim Material: Steel sheet.

E. Door Material: Steel sheet.

F. Door Style: Glazed.

G. Door Glazing: Tempered float glass (clear).

H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide door pull and friction latch.
2. Provide concealed hinge permitting door to open 180 degrees.

I. Accessories:

1. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.

a. Identify AED cabinet with the words "EMERGENCY DEFIBRILLATOR."

1) Location: Applied to cabinet door glass.
2) Application Process: Pressure-sensitive vinyl letters.
3) Lettering Color: Red.
4) Orientation: Horizontal.

J. Finishes:

1. Manufacturer's standard baked-enamel paint for the following:

a. Exterior of cabinet door except for those surfaces indicated to receive another finish.
b. Interior of cabinet and door.

2.4 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for hose valves and cabinets to verify actual locations of piping connections before cabinet installation.

B. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below:

1. Fire Protection Cabinets: 54 inches above finished floor to top of cabinet.

B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.
2. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

3. Fire-Rated, Hose-Valve Cabinets:

a. Install cabinet with not more than 1/16-inch tolerance between pipe OD and knockout OD. Center pipe within knockout.
b. Seal through penetrations with firestopping sealant as specified in Division 07 Section "Penetration Firestopping."

C. Identification: Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.

E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers.

B. Related Sections:

1. Division 10 Section "Fire Extinguisher Cabinets."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.

C. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.6 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. J. L. Industries, Inc.; a division of Activar Construction Products Group.
b. Larsen's Manufacturing Company.
c. Potter Roemer LLC.

B. Multipurpose Dry-Chemical Type: UL-rated minimum 3A-40BC nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.2 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. J. L. Industries, Inc.; a division of Activar Construction Products Group.
b. Larsen's Manufacturing Company.
c. Potter Roemer LLC.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Horizontal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 105115 - HDPE LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. High Density Polyethylene (HDPE) lockers.
2. Locker benches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of HDPE locker and bench.

B. Shop Drawings: For HDPE lockers. Include plans, elevations, sections, details, and attachments to other work.

1. Show locker trim and accessories.
2. Include locker identification system and numbering sequence.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For HDPE lockers and locker benches, in manufacturer's standard sizes.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.6 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Full-size units of the following HDPE locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than five units:

a. Identification plates.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain HDPE lockers, locker benches, and accessories from single source from single manufacturer.

C. Regulatory Requirements: Where HDPE lockers and benches are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver HDPE lockers until spaces to receive them are clean, dry, and ready for their installation.

B. Deliver master and control keys to Owner by registered mail or overnight package service.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.10 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that HDPE lockers can be supported and installed as indicated.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of HDPE lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Delamination or breakage of plastic components.
c. Faulty operation of latches and other door hardware.

2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for HDPE Lockers: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HDPE LOCKERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Bradley Corporation; Lenoxlocker.
2. Penco Products, Inc.; Aquarian Lockers.
3. Scranton Products, Inc.; Tufftec Lockers

B. Material: High impact, high density polyethylene plastic (HDPE) formed from polymer resins under high pressure with homogenous color.

C. Body: Sides, shelves, tops and bottoms shall be made from polymer resins formed under high pressure to solid plastic components, minimum 3/8" thick with homogeneous color.

D. Doors shall be made from polymer resins formed under high pressure to a solid plastic component, minimum 1/2" thick with homogeneous color.

E. Door frames shall be made from polymer resins formed under high pressure to a solid plastic component, minimum 1/2" thick with homogeneous color.

1. Door Style: Perforated Vents: Manufacturer's standard shape and configuration.

F. Continuous Hinges: Manufacturer's standard, stainless steel, full height.

G. Latch: Full length latch shall be made from high impact HDPE plastic and capable of accepting various locking mechanisms. Runs entire length of door, providing a continuous security latching system. Latch lifts up to open and returns to closed position after door is closed. Latch bar is secured to locker door with stainless steel security screws.

H. Combination Padlocks: Key-controlled, three-number dialing combination locks; capable of five combination changes.

I. Built-in Combination Locks: Key-controlled, three-number dialing combination locks; capable of at least five combination changes made automatically with a control key.

1. Bolt Operation: Manually locking deadbolt or automatically locking spring bolt.

J. Equipment: Equip each HDPE locker with identification plate and the following unless otherwise indicated:

1. Coat Hooks: Made from steel, zinc plated to resist corrosion and attached to intermediate shelves at the locker sides using hardware supplied by the manufacturer. Provide two per opening on 12" and 15" wide single, double and triple tier openings. 2 additional hooks are supplied at the rear of 18" wide lockers.

K. Accessories:

1. Base: Constructed of nominal 1 inch thick HDPE with homogeneous color to match locker body set back 3" from locker front to provide toe clearance.

   a. Height: 4 inches.

2. Continuous Sloping Tops: Fabricated from single sheet of HDPE, with a pitch of approximately 20 degrees.

   a. Closures: Vertical-end type.

3. Recess Trim: Fabricated from 3/8 inch nominal-thickness HDPE.
4. Filler Panels: Fabricated from 3/8 inch nominal-thickness HDPE.
5. End Panels: Fabricated from 3/8 inch nominal-thickness HDPE.

   a. Form end panels to match sloped tops where they occur.

L. Finish: HDPE locker to be homogenous color with matte or :"orange peel" surface finish.

1. Color(s): As selected by Architect from manufacturer's full range.

2.2 LOCKER BENCHES

A. Provide bench units with overall assembly height of 17-1/2 inches .

B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges fabricated from 1 ½ inch thick HDPE.

1. Size: Minimum 10 inches wide by length indicated.

C. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:

1. Tubular Steel: 1-1/4-inch- diameter steel tubing, with 0.1265-inch- thick steel flanges welded at top and base; with baked-enamel finish; anchored with exposed fasteners.

   a. Color: Match HDPE lockers.

2.3 FABRICATION

A. Fabricate HDPE lockers square, rigid, and without warp and with HDPE faces flat and free of dents or distortion. Make exposed HDPE edges safe to touch and free of sharp edges and burrs.

1. Locker box fabricated from a single sheet of HDPE with corners fused together. Weld frame and shelves to box assembly.
2. Attach hinge to door and frame with vandal-resistant double threaded stainless steel screws.
3. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

B. Fabricate each HDPE locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.

D. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high.

E. Continuous Base: Fabricated in lengths as long as practical to enclose base and base ends of HDPE lockers; finished to match lockers.

F. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.

G. Recess Trim: Fabricated in lengths as long as practical; finished to match lockers.

H. Filler Panels: Install filler panels and end panels using concealed fasteners. Provide flush hairline joints against adjacent surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine locker area with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. using concealed fasteners.
2. Fasten adjoining locker units together to provide rigid installation.
3. Anchor single rows of HDPE lockers to walls near top and bottom of lockers.

B. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners.

1. Identification Plates: Attach identification plates to each locker door, near top, centered, with at least two fasteners.
2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
3. Attach sloping-top units to HDPE lockers, with closures at exposed ends.
4. Attach end panels with concealed fasteners to all exposed ends of nonrecessed HDPE lockers.

C. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 48 inches apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor using appropriate anchors for the floor material..

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.

B. Protect HDPE lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

C. Touch up marred finishes, or replace HDPE lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105115

SECTION 106200 - DEMOUNTABLE STEEL OFFICE FRONT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes demountable steel office front system.

B. Related Requirements:

1. Section 081416 “Flush Wood Doors” for solid core wood doors used in demountable steel office front systems.
2. Section 087100 “Door Hardware” for door hardware and electric door hardware.
3. Section 088000 “Glazing” for glass panels used in demountable steel office front system.
4. Section 092216 “Non-Structural Metal Framing” for adjacent wall framing supports.

1.3 Summary

A. Furnish and install demountable steel office front system. Provide all labor, materials, tools and equipment for installation of metal and glass partition.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Shop Drawings: For demountable steel office front system.

1. Include plans, elevations, sections, details, and attachments to other work.

D. Samples for Initial Selection: For each type of exposed material and finish.

1. Manufacturer’s color charts showing a full range of colors and finishes available.

E. Samples for Verification: For each type of exposed material and finish, prepared on Samples of size indicated below:

1. Sample of actual frame member, minimum 12 Inches long, in color finish as selected.
2. Include Samples of accessories involving color selection.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of demountable steel office front system.

C. Product Test Reports: For each demountable steel office front system, for tests performed by a qualified testing agency.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For demountable steel office front system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Single-Source Responsibilities: Obtain panel system from one source by a single manufacturer.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Acoustical Performance: Provide demountable steel office front system tested by a qualified testing agency for the following acoustical properties according to test methods indicated:

1. Sound-Transmission Requirements: Demountable steel office front system tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, with an STC rating of not less than 45.

B. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   a. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 450 or less.

C. Demountable steel office front system shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

1. Failure also includes the following:

   a. Glass breakage.
   b. Loosening or weakening of fasteners, attachments, and other components.
   c. Failure of operating units.

2.2 DEMOUNTABLE STEEL OFFICE FRONT SYSTEM

A. Demountable Steel Office Front System: Partition system, including posts, bases, ceiling channels, panels, and accessories.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Inscape Architectural Interiors: Acme 50 Series.
   b. KI, Inc.: Genius Wall.
   c. Starwall USA: Classic series.

B. Demountable Steel Office Front System Framing Components: manufacturer's standard system components including posts, bases and ceiling channels formed from minimum 18 gauge cold-rolled powder coated steel.

1. Frame depth: Not more than 3 1/8 inches.

C. Wall Panel: Infill panel with acoustical material core and powder coated minimum 18 gauge face sheets finished to match framing members.

1. Thickness: Match frame depth.

D. Doors: System to receive doors and hardware specified under Section 081416 "Flush Wood Doors" and section 087100 "Door Hardware", including electric hardware where indicated.

E. Glazing: Glass as specified shall be furnished and installed with clear silicone caulking.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install panel systems rigid, level, plumb and aligned. Provide continuous seal to prevent light and sound transmission at floor, ceiling, fixed walls, and adjacent surfaces.

END OF SECTION 106200

SECTION 106710 - STORAGE SHELVING

PART 1 GENERAL

1.1 SUMMARY:

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, and Drawings apply to work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessories, necessary to furnish, deliver and install:
1. Stainless Steel Storage Shelving

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

1.2 DESIGN REQUIREMENTS:

A. Manufacturer is responsible for designing and sizing units to meet specified load requirements.

1.3 SUBMITTALS:

A. General: Submit in accordance with Division 01.

B. Product Data: Submit technical data and descriptive literature for each product.

C. Shop Drawings: Submit drawings indicating all layouts, types, spacing, and attachment details for the types of storage shelving specified herein.

1.4 COORDINATION

A. Coordinate with other sections of the specifications to insure that proper provisions are made for the installation of the work specified herein.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Division 01.

1.6 WARRANTY

A. Comply with requirements of Division 01.

B. Provide lifetime warranty against corrosion and rust. Warrant units to be free from defects in material and workmanship for 5 years from date of purchase. Include coverage against defects that may arise during the warranty period except those which are caused by misuse.

PART 2 PRODUCTS

2.1 STAINLESS STEEL STORAGE SHELVING:

A. Acceptable Manufacturers:

1. Metro Industries Corp., Wilkes-Barre, PA (Metro Super Erecta Shelving System)
2. Eagle MHC, Smyrna, DE
3. Allen Company Fabricators, Minneapolis, MN

B. Type: Free standing shelving system with open ends, open backs, fixed top and bottom shelves, and four (4) adjustable intermediate shelves.

C. Construction:
1. Shelves shall be Open Wire Design.
2. Intermediate shelves to be fully adjustable in 1” increments without use of tools.
3. All components shall be stainless steel.
4. Units shall not require lateral cross-bracing.
5. Four (4) Stationary posts. Post design with double grooves every 8" to provide a visual guide for positioning and adjusting shelves.
6. All freestanding shelving shall be capable of being leveled at the base of the posts with leveling screws
7. Dimensions: 86 5/8” high, depth and width as indicated on drawings.
8. Finish: Type 304 stainless steel with a No. 4 finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with Division 01.

3.2 INSTALLATION

A. Install in accordance with Division 01, and approved shop drawings.

B. Assemble and install metal storage shelving at locations indicated on the drawings. Install all intermediate loose shelves at spacing indicated.

C. Level each unit to compensate for any floor irregularities. Posts shall be aligned with adjacent units and each post shall rest securely on the floor.

D. Protect metal storage shelving from defacement, scratching or other defects after installed and until final acceptance of the project. Do not allow other trades to store construction materials on shelving. Replace any damaged or defaced units prior to final inspection and acceptance of the project at no additional cost to the Owner.

END OF SECTION 106710

SECTION 110800 – SPECIALTY EQUIPMENT COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment testing and start-up

B. Validation of proper and thorough installation of Division 11 Special Equipment

C. Documentation of tests, procedures, and installations

D. Coordination of Training Events

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) is retained by the Owner shall work with the Contractor and the Design Engineer to direct and oversee the Cx process and perform functional performance testing.

C. This Section outlines the Cx procedures specific to the Division 11 Contractors. Requirements common to all Sections are specified in Sections 019113 and 019114 and the Cx Plan.

1.3 SCOPE

A. The following are included in the Scope of Commissioning on this project:

1. Specialty Equipment such as Food Service equipment, Projection Screens, Laboratory Equipment, Sterilizing and Washing Equipment, etc. that will require permanent connection to the mechanical, electrical or plumbing infrastructure of the facility (i.e. not simply plugging into an outlet) or is scheduled to be monitored and/or controlled by the Building Management System (BMS).

1.4 RELATED WORK AND DOCUMENTS

A. Section 019113 – General Commissioning Requirements: details the Cx requirements common across all divisions

B. Section 019114 – Functional Testing Procedures: Outlines the generic functional testing procedures required.

C. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

D. Section 220800 – Plumbing Systems Commissioning: Details the commissioning procedures specific to Division 22 Plumbing work.

E. Section 230800 – HVAC Systems Commissioning: Details the commissioning procedures specific to Division 23 HVAC work.

F. Section 230995 – Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.

G. Section 260800 – Electrical Systems Commissioning: Details the commissioning procedures specific to Division 26 work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113

1.6 REFERENCE STANDARDS

A. ASHRAE Guideline 1-1996, "Guideline for Commissioning HVAC Systems"

B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”

C. NEBB – Procedure Standards for Building Systems Commissioning

1.7 DOCUMENTATION

A. In addition to the documentation required in Section 019113, Contractor shall provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format.
2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in pdf electronic format.

1.8 CONTRACTOR/VENDOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 11.

B. Construction Phase

1. Provide skilled technicians qualified to perform the work required.
2. Provide factory-trained and authorized technicians where required by the Contract Documents.
3. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
4. Start-up, and test/adjust/balance systems and equipment as detailed throughout Contract Documents.
5. Record Start-up Procedures on start-up procedure forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.

C. Acceptance Phase

1. Assist CA in functional performance testing. Assistance will generally include the following:

   a. Provide any specialized instrumentation necessary for functional performance testing;
   b. Manipulate BAS and other control systems to facilitate functional performance testing.

D. Warranty Phase

1. Maintain record documentation of any configurations, set ups, parameters etc, that change throughout the period.
2. Respond to Warranty issues as required by Division 1 and the General Conditions.

1.9 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 PROCEDURES COMMON TO ALL SYSTEMS

A. The following start up verifications/procedures are common to all systems

B. Checkout shall proceed from devices to the components to the systems.

C. Verify labeling is affixed per spec and visible

D. Verify prerequisite procedures are done.

E. Inspect for damage and ensure none is present.

F. Verify system is applied per the manufacturer's recommendations

G. Verify system has been start up per the manufacturer's recommendations

H. Verify that access is provided for inspection, operation and repair

I. Verify that access is provided for replacement of the equipment

J. Verify the record drawings, submittal data and O&M documentation accurately reflect the installed systems

K. Verify all gages and test ports are provided as required by contract documents and manufacturer's recommendations

L. Verify all recorded nameplate data is accurate

M. Installation is done to ensure safe operation and maintenance.

N. Verify specified replacement material/attic stock has been provided as required by the Construction Documents

O. Verify all rotating parts are properly lubricated

P. Verify all monitoring and ensure all alarms are active and set per Owner's requirements

Q. Complete all nameplate data and confirm ratings conform with the design documents

END OF SECTION 110800

SECTION 114000 - FOODSERVICE EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fabricated equipment.
2. Food waste machines.
3. Cooking equipment.
4. Self-contained refrigeration equipment.
5. Powered food-preparation equipment.
6. Warewashing equipment.
7. Serving equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Manufacturer's model number.
2. Accessories and components that will be included for Project.
3. Clearance requirements for access and maintenance.

B. Shop Drawings: For fabricated equipment. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachments to other work.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each factory-applied color finish required, in manufacturer's standard sizes.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For foodservice facilities.

1. Key equipment using same designations as indicated on Drawings.
2. Include plans and elevations; clearance requirements for equipment access and maintenance; details of equipment supports; and utility service characteristics.

B. Warranty: Samples of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For foodservice equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data,"," include the following:

1. Product Schedule: For each foodservice equipment item, include the following:

a. Designation indicated on Drawings.
b. Manufacturer's name and model number.
c. List of factory-authorized service agencies including addresses and telephone numbers.

1.6 QUALITY ASSURANCE

A. NSF Standards: Provide equipment that bears NSF Certification Mark or UL Classification Mark certifying compliance with applicable NSF standards.

B. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.

C. Regulatory Requirements: Install equipment to comply with the following:

1. NFPA 70, "National Electrical Code."
2. National Sanitation Foundation (NSF) Certification or equivalent.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with foodservice equipment by field measurements before fabrication. Indicate measurements on Coordination Drawings.

1.8 COORDINATION

A. Coordinate foodservice equipment layout and installation with other work, including layout and installation of lighting fixtures, HVAC equipment, and fire-suppression system components.

B. Coordinate sizes, locations, and requirements of the following:

1. Overhead equipment supports.
2. Equipment bases.
3. Floor depressions.
4. Insulated floors.
5. Floor areas with positive slopes to drains.
6. Floor sinks and drains serving foodservice equipment.
7. Roof curbs, equipment supports, and penetrations.

1.9 WARRANTY

A. Refrigeration Compressor Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace compressors that fail in materials or workmanship within specified warranty period.

1. Failure includes, but is not limited to, inability to maintain set temperature.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FABRICATED EQUIPMENT

A. Stainless-Steel Sinks:

1. General:

a. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated on Drawings or comparable products by one of the following:

1) Eagle Group, Inc.
2) John Boos Company.

b. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
c. Fabrication: All welded construction ground smooth and blended.

1) Bowls: Stainless steel, Type 304, 0.062 inch thick.
2) Body: Stainless steel, Type 304, 0.062 inch thick.
3) Back Splash: Stainless steel, Type 304, 0.062 inch thick. Manufacturer's standard height.
4) Legs and Feet: Stainless-steel tubing legs with adjustable bullet feet.
5) Accessories:

a) Faucets and Spouts: As indicated on Plumbing Drawings.
b) Vacuum breaker.
c) Basket strainer.

6) Prepare sink for installation of the following equipment items where indicated:

a) Food waste disposer; weld disposer cone or collar into sink.

d. Stainless-Steel Finish: Directional satin finish No. 4.

2. Stainless-Steel Three Compartment Sink: Drawing designation 1.

a. Description: Three-compartment in-line sink with two drainboards. Fabricate units of welded stainless steel, sound deadened.
b. Integral Drainboards: Stainless steel, Type 304, 0.062 inch thick.
c. Faucet: Drawing designation 2.

1) Splash mount mixing faucet.
2) 12” swing nozzle.

3. Stainless-Steel One Compartment Sinks: Drawing designation 3.

a. Description: One-compartment sink with integral left hand drainboard. Fabricate units of welded stainless steel, sound deadened.

1) Integral Drainboard: Stainless steel, Type 304, 0.062 inch thick.

b. Faucet: Drawing designation 4.

1) Splash mount mixing faucet.
2) 6" swing nozzle.

4. Stainless-Steel Hand Sinks: Drawing designation 21.

a. Description: Lavatory sink. One piece sink bowl design with splash mounted faucet.

1) Operation: Handle.
2) Faucet: Gooseneck with aerator.
3) Accessories:

a) Strainer basket with metal post.
b) Liquid soap dispenser, wall mounted.
c) Towel dispenser.
d) Side splashes.

5. Stainless-Steel Utility Sink: Drawing designation 22.

a. Description: Floor mounted service sink, 10 inch height.

1) Service Faucet: As indicated on Drawings with hose & bracket.

B. Stainless-Steel Tables:

1. General:

a. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated on Drawings or comparable products by one of the following:

1) Eagle Group, Inc.
2) John Boos Company.

b. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
c. Stainless-Steel Finish: Directional satin finish No. 4.
d. Fabrication: All welded construction ground smooth and blended.

1) Stainless steel top: Type 304, 0.062 inch thick.
2) Back Splash: Stainless steel, Type 304, 0.062 inch thick. Manufacturer's standard height.
3) Legs and Feet: Stainless-steel tubing legs, type 304, 0.062 inch thick, with adjustable bullet feet.
4) Cross bracing: Welded stainless steel.

2. Clean Table: Drawing designation 5.

a. Description: Dish table with 3-inch high rolled rims, right hand.

3. Soil Table: Drawing designation 7.

a. Description: Dish table with 3-inch high rolled rims, left hand.

b. Sink: Stainless steel, Type 304, 0.062 inch thick, welded into tabletop and including the following:

1) Pre-rinse spray: Drawing designation 8.

a) Single Deck Mount base with hot- and cold-water mixing valve and with stainless-steel exposed metal parts.
b) Wall support bracket.
c) Flexible, 3/8-inch metal-encased hose with a minimum length of 44 inches and supported by spiral spring.
d) Spray-head assembly with lockable lever handle.

2) Basket strainer.
3) Tail piece.
4) Prepare sink for installation of food waste disposer; weld disposer cone or collar into sink.

4. Corner Table: Drawing designation 11.

a. Description: Stainless steel corner table with integral splash.
b. Prepare table for installation of the following equipment items where indicated:

1) Glass Filler: Provide cut out in top to template. Reinforce cut out edges as required..

C. Stainless-Steel Dish Cabinet: Drawing designation 10.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Eagle Group, Inc.
b. John Boos Company.

2. Description: Open faced base cabinet, all welded stainless steel with rolled front edge.

a. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
b. Fabrication: All welded construction ground smooth and blended.

1) Top: Stainless steel, Type 304, 0.078 inch thick, sound deadened.
2) Body: Stainless steel, Type 430, 0.062 inch thick.
3) Shelf: Stainless steel, Type 430, 0.062 inch thick, fixed centered.
4) Legs and Feet: Stainless-steel tubing legs, type 304, 0.062 inch thick, with adjustable bullet feet.

c. Stainless-Steel Finish: Directional satin finish No. 4.

D. Stainless-Steel Shelf Units: Drawing designation 19, 20, and 25.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Eagle Group, Inc.
b. John Boos Company.

2. Description: Wall mounted. Fabricate units of stainless steel, Type 304, 0.050 inch thick.
3. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
4. Stainless-Steel Finish: Directional satin finish, No. 4.

E. Stainless-Steel Cleaning Storage Shelf: Drawing designation 23.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Eagle Group, Inc.
   b. John Boos Company.

2. Description: Wall mounted utility shelf with integral mop hangers and towel hooks. Fabricate units of stainless steel, Type 304, 0.050 inch thick.
3. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
4. Stainless-Steel Finish: Directional satin finish, No. 4.

F. Stainless-Steel Mop Hanger: Drawing designation 24.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Eagle Group, Inc.
   b. John Boos Company.

2. Description: Wall mounted mop hangers with three spring loaded rubber holders.
3. Fabricate units of stainless steel, Type 304, 0.050 inch thick.
4. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, type as indicated.
5. Stainless-Steel Finish: Directional satin finish, No. 4.

2.2 FOOD WASTE MACHINES

A. Food Waste Disposer Units: Drawing designation 9.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Hobart Corporation.
   b. Waste King.

2. Description: 1 hp, with dual-direction shredding elements, and the following:

   a. Stainless-steel housing.
   b. Flow control.
   c. Solenoid valve.
   d. Vacuum breaker.
   e. Fixed nozzle.
   f. Control Panel:

      1) Autoreversing and internal timed water flush.
      2) Stainless-steel mounting bracket.

   g. Electrical Service: Equip unit for connection to service indicated on Drawings.

2.3 COOKING EQUIPMENT

A. Microwave Ovens: Drawing designation 16.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Panasonic.
b. Summit Appliance.

2. Description: Countertop microwave oven, stainless steel exterior and interior.

a. Capacity: 1.2 cu. ft.
b. Cooking power: 1000-W.
c. Electrical Service: Equip unit with plug and cord for 120-V service.

B. Coffee Urns: Drawing designation 13.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Bunn.
b. Wilbur Curtiss Co.

2. Description: Twin urn, automatic refill, stainless steel construction.

a. Capacity: 6 gal. per liner.
b. Type: Electric heated.
c. Agitator: Automatic.
d. Timer: Electromechanical.
e. Accessories:

1) Multiple Faucet: no drip.
2) Filtering: Disposable filter pack.

3. Electrical Service: Equip unit for connection to service indicated on Drawings.

2.4 SELF-CONTAINED REFRIGERATION EQUIPMENT

A. Commercial Refrigerator: Catering Kitchen - Drawing designation 14.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Summit Appliance.
b. Turbo Air, Inc.

2. Description: Reach-in type.

a. Exterior Finish: Stainless steel.
b. Interior Finish: Stainless steel.
c. Doors: Full length.
d. Top mount compressor.
e. Accessories:

1) Casters.

f. Electrical Service: Equip unit with plug and cord for service indicated on Drawings.

B. Refrigerator: Locations other than Catering Kitchen.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Frigidaire.
b. GE Appliances.
c. KitchenAid; a division of Whirlpool Corporation.

2. Full Size Refrigerator/Freezer: Two-door refrigerator/freezer with freezer on bottom and complying with AHAM HRF-1.

a. Type: Freestanding.
b. Dimensions:

1) Width: 36 inches.
2) Depth: 27 inches.
3) Height: 70 inches.

c. Storage Capacity:

1) Refrigeration Compartment Volume: 15 cu. ft.
2) Freezer Volume: 6 cu. ft.
3) Shelves: Three tempered glass shelves.

d. General Features:

1) Door Configuration: Full-Door overlay.
2) Built-in ice maker.
3) Built-in water filtration system.
4) Separate temperature controls for each compartment.

e. Refrigerator Features:

1) Interior light in refrigeration compartment.
2) Door Storage: Modular compartments.

f. Freezer Features: One freezer compartment(s).

1) Automatic defrost.
2) Interior light in freezer compartment.

g. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

h. Front Panel(s): Stainless steel.

3. Under counter Refrigerator: One-door under counter refrigerator complying with AHAM HRF-1.

a. Dimensions:

1) Width: 24 inches nominal.
2) Depth: 24 inches.
3) Height: 34-1/2 inches.

b. Storage Capacity:

1) Refrigeration Compartment Volume: 5.6 cu. ft. min.

c. General Features:

1) Door Configuration: Overlay.
2) Temperature Control: Adjustable.

d. Refrigerator Features:

1) Interior light in refrigeration compartment.
2) Ice tray freezer compartment.

e. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

f. Front Panel(s): Stainless steel.

C. Ice-Making Machine: Drawing designation 15.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Ice-O-Matic.
b. Scotsman Ice systems.

2. Description: Freestanding air-cooled unit.

a. Production: Ice cubes.
b. Capacity: 500 lb. per 24-hour period.
c. Accessories:

1) Storage Bin: As indicated on Drawings .

a) Storage Capacity: 500 lb.
b) Exterior finish: Stainless steel.
c) Polyethylene bin liner.

2) Backflow preventer.
3) Water filter.

d. Electrical Service: Equip unit for connection to service indicated on Drawings.

2.5 WATER STATION

A. Glass Filler: Counter mount glass filler with drain.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Grindmaster.
    b. Randell.

B. Accessories: Equip glass filler unit with the following:

1. Backflow preventer
2. Inline commercial water filter.

2.6 WAREWASHING EQUIPMENT

A. Warewashing Machines: Door type high temperature dish machine.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. CMA Dishmachines.
    b. Hobart Corporation.

2. Description: Dishwashing, single tank.

    a. Normal Operating Capacity: 40 racks per hour.
    b. Construction: All stainless steel.
    c. Electrical Service: Equip unit for connection to service indicated on Drawings.

2.7 SERVING EQUIPMENT

A. Moveable Warmer Rack: Drawing designation 27.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Carter-Hoffman.
    b. FWE Food Warming Equipment Company, Inc.

2. Description: Low temperature double cavity hot holding cabinet.

    a. Capacity: Two compartments each minimum 7.5 cu. ft.
    b. Exterior Finish: Stainless steel.
    c. Accessories:

        1) Casters.
        2) Full perimeter bumper.
        3) Door lock with key.

    d. Electrical Service: Equip unit for connection to service indicated on Drawings.

B. Banquet Cart: Drawing designation 28 and 29.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Alto-Shaam, Inc.
b. Carter-Hoffman.

2. Description: Dual-heat mobile banquet cabinets.

a. Sizes as indicated on Drawings.
b. Exterior Finish: Stainless steel.
c. Interior Finish: Stainless steel.
d. Accessories:

1) Casters.
2) Full perimeter bumper.
3) Door lock with key.

e. Electrical Service: Equip unit for connection to service indicated on Drawings.

2.8 MISCELLANEOUS MATERIALS

A. Installation Accessories, General: NSF certified for end-use application indicated.

B. Elastomeric Joint Sealant: ASTM C 920; silicone. Type S (single component), Grade NS (nonsag), Class 25, Use NT (nontraffic) related to exposure, and Use M, G, A, or O as applicable to joint substrates indicated.

1. Public Health and Safety Requirements:

a. Sealant is certified for compliance with NSF standards for end-use application indicated.
b. Washed and cured sealant complies with the FDA's regulations for use in areas that come in contact with food.

2. Cylindrical Sealant Backing: ASTM C 1330, Type C, closed-cell polyethylene, in diameter greater than joint width.

2.9 FINISHES

A. Stainless-Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Powder-Coat Finishes: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard, baked-polymer, thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install foodservice equipment level and plumb, according to manufacturer's written instructions.

1. Connect equipment to utilities.
2. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections.

B. Complete equipment assembly where field assembly is required.

1. Provide closed butt and contact joints that do not require a filler.
2. Grind field welds on stainless-steel equipment until smooth and polish to match adjacent finish.

C. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and with requirements of authorities having jurisdiction.

D. Install cabinets and similar equipment on bases in a bed of sealant.

E. Install closure-trim strips and similar items requiring fasteners in a bed of sealant.

F. Install joint sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Produce airtight, watertight, vermin-proof, sanitary joints.

3.2 CLEANING AND PROTECTING

A. After completing installation of equipment, repair damaged finishes.

B. Clean and adjust equipment as required to produce ready-for-use condition.

C. Protect equipment from damage during remainder of the construction period.

3.3 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain foodservice equipment.

END OF SECTION 114000

SECTION 115213 - PROJECTION SCREENS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Type A: Ceiling hung, permanently tensioned, electric operation projection screens with 94" diagonal viewing area (16:10 aspect ratio image size).
   2. Type B: Ceiling hung, permanently tensioned, electric operation projection screens with 109" diagonal viewing area (16:10 aspect ratio image size).
   3. Type C: Ceiling hung, permanently tensioned, electric operation projection screens with 137" diagonal viewing area (16:10 aspect ratio image size).
   4. Type D: Ceiling hung, permanently tensioned, electric operation projection screens with 189" diagonal viewing area (16:10 aspect ratio image size).
   5. All electronic screens shall be equipped with 24 volt wall mounted remote three-position control switch (Draper LVC-S or approved comparable product) with cover and plate located adjacent to the projection screen, along with low voltage interface (Draper LVC-III or approved comparable product) or approved comparable product) to audiovisual remote control systems.

1.3 RELATED SECTIONS

A. Division 05 Section *Metal Fabrications* for support and hanging systems.

B. Sections of Division 26 for electrical wiring, connections, and installation of control switches for electrically operated equipment.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for each piece of equipment.

B. Shop Drawings: Submit shop drawings for each type of equipment.

1.5 QUALITY ASSURANCE

A. Obtain each type of equipment required from a single manufacturer as complete units, including necessary hardware and accessories.

B. Measure gain of screen viewing surface against that of a magnesium carbonate surface by means of a photogoniometer using testing methods and test apparatus per FS GG-S-00172D (l) for determining the effect of reflected light at various viewing angles on screen surfaces.

C. Provide screen fabrics identical to those materials which have undergone testing and passed requirements for flame resistance as outlined in NFPA 701 per small sample test.

D. Provide a seamless mildew resistant screen fabric as determined by Federal Standard 191 A/5760.

E. State of the Art Development
   1. Supply only the manufacturer's latest developed product. In cases where product development surpasses the criteria of the specification, inform the Architect and make the newer product available to the project at no additional cost. In no case shall discontinued or obsolete product be acceptable. The same requirement applies to software programs developed/updated during the warranty period.
   2. Should the product recall by the manufacturer require temporary or permanent replacement of a product specified under this section, notify the Architect at the earliest reasonable time and arrange to replace the product in question at the earliest possible time.
      a. Product found defective or subject to recall prior to scheduled installation shall not be delivered to the jobsite.
      b. Product defect or intended recall shall not relieve the manufacturer from his contractual obligation with regard to delivery schedule of product.
      c. Under no circumstances shall arrangement for alternate product necessarily require the Owner to accept superseded equipment except on a temporary basis.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Comply with the manufacturers requirements for temperature and humidity conditions.

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work to include, but are not limited to, the following:
   1. Electric projection screens:
      a. Access V; Draper; Spiceland IN; 800-238-7999.
      b. Tensioned Advantage Electrol; Warsaw, IN; 800-622-3737
      c. Model A & B; Stewart Filmscreen; Torrance CA; 800 762 4999.
   2. Projection screen locations shall be in areas as indicated on "TA" Series drawings:
      a. Type A: 94-inch (diagonal measure), 16:10 aspect ratio.
      b. Type B: 109-inch (diagonal measure), 16:10 aspect ratio.
      c. Type C: 133-inch (diagonal measure), 16:10 aspect ratio.
      d. Type D: 189-inch (diagonal measure), 16:10 aspect ratio.

2.2 MATERIALS AND FABRICATION

A. Provide each electrically operated, ceiling recessed front projection screens manufactured as an integral unit consisting of roller, screen fabric, finished retracting "trap-door" assembly, mounting accessories and all other components for a complete installation and complying with all requirements.

B. The unit shall be UL-listed and bear UL re-examination markers. Screen limitation drop, or permanent mounting position, will position the bottom of the displayed image as listed below. Verify drop distance with ceiling height information prior to ordering equipment.
   a. Type A: 48-inches above finish floor.
   b. Type B: 48-inches above finish floor.
   c. Type C: 48-inches above finish floor.
   d. Type D: 48-inches above finish floor.

C. Fabric: The image area shall be a completely seamless, polyvinyl, white fabric with a gain of 1.0 to 1.3. It shall have a black border, black backing and be cable-tensioned to eliminate edge curl, sag, and center wrinkle; equivalent to M1300 by Draper.

D. Case: Aluminum or steel, and fire-retardant hardboard, with removable access panels on the bottom or side of the case. The unit shall have an integral motorized trap door. The case shall be finished to match ceiling on the bottom.

E. Motor: Size and capacity as recommended by the manufacturer for the screen. Provide an instant reversing, gear driven, or in roller, motor with permanently lubricated ball bearings, automatic thermal overload protection, and preset limit switches to automatically stop the screen in the fully "UP" or "DOWN"" position. The stop action shall be positive to prevent coasting. The motor shall be acoustically isolated to limit operating noise.

F. Control: Provide low voltage (24 volts or less) controls wired to a junction box on the screen wall and to the associated audiovisual equipment rack. The wall plate shall have push button control for "UP", "DOWN", and "STOP". The same control functions shall be present at the junction box in the audiovisual control system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment at locations indicated in compliance with the manufacturers instructions, including, but not limited to, Installation Instructions.

B. Install in position and relationship to adjoining work indicated, securely anchored to supporting substrate, sealed and finished, and in a manner, which produces a smooth screen with square, plumb, and straight edges.

C. Install with proper clearance between the gypsum board, the ceiling tiles, the screen, and the jam. Electric screens are to be installed with housing (case) concealed just above room ceiling tiles. Provide cutout opening with finish in drop tile or hard ceiling for screen drop.

D. The equipment shall be inspected upon arrival to the job site. The equipment shall be stored in their original crates until installation.

3.2 ADJUST AND CLEAN

A. Protect equipment after installation from damage during construction including, but not limited to, paint, scratches, and dirt. If, despite such protection, damage occurs, remove and replace damaged components or entire unit as required to restore units to their original, undamaged condition.

B. Adjust assembly after installation for proper operation and screen drop/ retract.

END OF SECTION 11 52 13

SECTION 116000 - LABORATORY EQUIPMENT - GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, and Drawings, apply to Work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessories, necessary to furnish, deliver and install:
   1. Section 116100 – Sterilizing and Washing Equipment:
      Autoclaves, Glass Washers and Pass-Through Box
   2. Section 116500 – Miscellaneous Laboratory Equipment:
      DI Polishers and Ice Makers

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. This Section also includes all general requirements, applicable to this and all other Equipment Specification Sections including, but not limited to:
   Definitions
   System description
   Scope
   Submittals
   Quality assurance
   Mock-up
   Testing
   Field measurements
   Pre-installation conference
   Delivery, storage and handling
   Project conditions
   Sequencing
   Materials
   Components
   Finish and performance requirements
   Examination, Installation, Adjusting, Cleaning and Protection Requirements

E. Related Sections:
   1. Section 123090 - Laboratory Service Fixtures
   2. Section 123450 - Metal Laboratory Casework and Hoods
   3. Section 123460 - Wood Laboratory Casework
   4. Section 130390 - Controlled Environment Rooms: Cold Room
   5. Divisions 22 & 23 - Mechanical: Mechanical Connections
   6. Division 26 - Electrical: Electrical Connections

F. Quality Assurance
   1. Single Source Responsibility:
      a. Furnish products for each type of equipment from one manufacturer for entire Project, unless otherwise acceptable to Architect.
      b. Provide each product as complete unit, including accessory items necessary for proper operation.
   2. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum 5 years documented experience.

3. Installer Qualifications: Manufacturer, or approved in writing by manufacturer.

1.2 SUBMITTALS

A. Shop drawings:
1. Indicate typical layout including dimensions, locations, large-scale plans, elevations, cross sections, rough-in and anchor placement dimensions and tolerances, and clearances required.
2. Submit detail drawings of special accessory components not included in manufacturer's product data.

B. Product Data:
1. Submit manufacturer's descriptive literature and product specifications for each product.
2. Include data to indicate equipment dimensions and construction, equipment capacities, and point loads.
3. Include information for factory finishes, hardware, glass, sealants, accessories and other required components.
4. Include wiring diagrams and rough-in requirements.

C. Samples:
1. Finishes.
2. Include color charts for finish indicating manufacturer's full range of colors available for selection.

D. Qualification Data:
1. Submit manufacturer's and installer's qualifications verifying experience.
2. Include list of completed projects having similar scope of Work identified by name, location, date, reference names, and phone numbers.

E. Manufacturer's Instructions: Submit manufacturer's printed installation instructions.

F. Operation and Maintenance Data:
1. Submit manufacturer's printed, recommended operation and maintenance data.
2. Include description of equipment operations, adjusting, and testing.
3. Identify system maintenance requirements, servicing cycles, and spare part sources.

G. Warranty: Submit specified warranty in accordance with Division 01.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:
1. Manufacturer is responsible for designing units, including anchorage of units to structural system and necessary modifications to meet specified requirements and maintain visual design concepts.
2. Dimensions, voltages, electrical power requirements, and utility connections are based on the items specified. Contractor is responsible for all costs for dimensional adjustments and for providing or arranging for additional electrical or utility services or equipment required as a result of using an equal product.
3. Provide concealed fastening wherever possible.
4. Attachment considerations: Account for site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening and fracturing connection between utility connections and units.
5. Equipment may be inspected by Owner at manufacturer’s plant prior to shipment. Equipment found not in accord with specifications and approved Drawings may be rejected. Replace rejected equipment at no cost to Owner.

6. Electric operated and/or heated equipment: Comply with latest standards of National Electrical Manufacturer's Association (NEMA), National Electric Code (NEC) and Underwriters' Laboratories, Inc., (UL).

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Contractor furnished, Contractor installed equipment (C/C):
   1. Contractor shall be responsible for furnishing and installing equipment.
   2. Contractor to deliver to site in manufacturer's original labeled containers, and to store equipment to prevent damage to materials or structure in dry, weathertight, ventilated spaces, protect exposed surfaces and edges until work is completed, and repair or remove and replace damaged or rejected work.

B. Owner furnished, Contractor installed equipment (O/C):
   1. New Equipment:
      a. Owner/Tenant will be responsible for shipping these items to project site.
      b. Contractor shall be responsible for unloading, handling, storing, unpacking, assembling, installing and connecting equipment, and removing debris.
      c. Contractor to store equipment to prevent damage to materials or structure in dry, weathertight, ventilated spaces, and to protect exposed surfaces and edges until work is completed.
   2. Existing Equipment:
      a. Owner/Tenant will disconnect, move, and place equipment in proximity of new location.
      b. Contractor shall be responsible for moving equipment to final location, unpacking, assembling, installing, and connecting equipment, and removing debris.
      c. Contractor to store equipment to prevent damage to materials or structure in dry, weathertight, ventilated spaces, and to protect exposed surfaces and edges until work is completed.

C. Owner furnished, Owner installed (O/O):
   1. Future equipment and "NIC" equipment (Not in Contract under Base Bid)
   2. Contractor to provide all structural, mechanical and electrical rough-in indicated.

1.5 JOB CONDITIONS

1. Drawings show arrangement and location of items of equipment. If it is necessary to vary from arrangement shown, because of structural, mechanical, electrical or other considerations, make such variations only after approval of Architect and at no additional expense to Owner.

B. Verify all dimensions at building.

C. Measure all recesses and openings at buildings and provide all trim pieces, fillers, and closures, in sizes required.

1.6 PRE-INSTALLATION CONFERENCE

A. Conduct pre-installation conference in accordance with Division 01.

B. Convene pre-installation conference one week prior to commencing work of this Section.

C. Attendance Required: Owner, Architect, Contractor, Manufacturer's Representative, and Installer.

D. Agenda: Discuss and agree upon acceptable substrate and support conditions, preparatory work, interface with mechanical and electrical services, and methods of installation and testing.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Acceptable manufacturers:
   1. Laboratory equipment: As noted for individual items.
   2. The Naming of manufacturer(s) and designation of product is for the purpose of identifying and describing required product and not to limit competition. Other manufacturers capable of producing the same appearance and having the same quality, durability, and performance may be proposed for use on this project subject to Architect's approval. Other approved manufacturers are responsible for all adjustments required to fit their products to the work at no additional cost.
   3. Provide equipment of each specialty type (as designated by Sections referenced) by one manufacturer, insofar as is possible, and except as otherwise indicated.

2.2 EQUIPMENT SCHEDULE

A. Refer to Equipment Schedule bound at the end of this Section.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with specifications.

B. Verify that utility connections are in place and correctly positioned.

C. Verify that rough-in frames, anchors, and supports are accurately placed.

D. Correct unsatisfactory conditions.

E. Start of work constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. Install in accordance with manufacturer's printed instructions and approved shop drawings.

B. Follow manufacturer's printed instructions or drawings in all cases where items or details are not indicated.

C. Except for final connection, installation of each item shall be complete in every respect.
   1. Provide all controls, regulating devices and all other accessories necessary for proper operation and maintenance of equipment including, but not necessarily limited to, pressure reducing valves, strainers, steam traps, control valves, relief valves, etc.
   2. Include all accessories whether or not they are specifically indicated.

D. Where an item of equipment is furnished without a cord and plug, electrical wiring in or on equipment shall be brought to an equipment junction box located on, and as a part of equipment, such that a flexible connection no longer than 3 ft will be needed to make a final connection between item and rough-in junction box.

E. Provide all stands, supports, sleeves, collars, escutcheons, brackets, braces or other miscellaneous items required for a complete installation.

F. Install equipment plumb, level, square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction and adjacent surfaces.

G. Repair or replace damaged, stained or rejected work.

H. Test and adjust all items of equipment for satisfactory operation.

I. Interface With Other Work: Coordinate equipment installation with size, location, and installation of service utilities.

J. Sequences of Operation: Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

3.3 CLEANING

A. Remove protective coverings from pre-finished units.

B. Clean as required by manufacturer. Do not use materials or methods, which may damage finish or surrounding construction.

C. Touch-up minor damaged surfaces caused during installation; replace damaged components as directed by Architect.

3.4 PROTECTION

A. Protect finished work.

3.5 OWNER INSTRUCTION

A. Perform instruction of Owner personnel: See Division 01.

END OF SECTION 116000

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
BE-01	Environmental Growth Chamber	NIC	O/O	N	F	32"Lx27"Wx72"H	VWR	2015	
BE-02	Wet Lab Table for Aquaria	NIC	O/O	N	F	72"Lx24"Wx36"H			
BE-03	EKG Machine	NIC	O/O	N	B	11"Lx13"Wx4"H	Burdick	EK10	Not Located
BE-04	BSL System	NIC	O/O	E	B	29"Lx25"Wx7"H	BIOPAC	MP35	Not Located
BE-05	BioSafety Cabinet	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	
BE-06	***NOT USED***								
BE-07	Refrigerator	NIC	O/O	N	F	54"Lx30"Wx79"H	VWR	Serial #1269359 GDM-49	Double Doors
BE-08	(-20º) Freezer	NIC	O/O	N	F	26"Lx22"Wx34"H	Fisher Isotemp	13-986-154	NEMA 5-15 Plug
BE-09	Refrigerator / Freezer	NIC	O/O	N	F	31"Lx30"Wx66"H	Fisher Isotemp	13-986-106A	NEMA 5-15 Plug
BE-10	Incubator	NIC	O/O	N	B	24"Lx26"Wx27"H	Fisher Isotemp	11-690-525D	Not Located
BE-11	Shaker Incubator	NIC	O/O	N	F	28"Lx21"Wx20"H	New Brunswick	M1283-000	
BE-12	Water Bath	NIC	O/O	E	B	32"Lx20"Wx10"H	Equatherm		Not Located
BE-13	Water Bath	NIC	O/O	E	B	14"Lx17"Wx11"H	VWR	1228	Not Located
BE-14	Water Bath	NIC	O/O	E	B	32"Lx20"Wx12"H	Precision	66634	Not Located
BE-15	Water Bath	NIC	O/O	E	B	15"Lx16"Wx14"H	Fisher Isotemp	210	Not Located
BE-16	Hot Stir Plate	NIC	O/O	N	B	9"Lx14"Wx4"H	Barnstead	SP 131325	Not Located
BE-17	Balance	NIC	O/O	N	B	8"Lx14"Wx4"H	Mettler Toledo	XS 2002S	Not Located
BE-18	Glassware Washer	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
BE-19	Ice Maker	116500	C/C	N	F	30"Lx34"Wx72"H	Scotsman	FME504AS-1A	with HTB555-H Storage Bin
BE-20	Drying Oven	NIC	O/O	N	B	24"Lx24"Wx49"H	VWR	1327F	
BE-21	Refrigerator	NIC	O/O	E	F	55"Lx34"Wx84"H	Hobart	32486581	Double Doors
BE-22	Incubator	NIC	O/O	E	F	47"Lx24"Wx37"H	National		Stacked above BE-23
BE-23	Incubator	NIC	O/O	E	F	42"Lx21"Wx36"H	Labline Imperial		Located under BE-22
BE-24	***NOT USED***								
BE-25	Refrigerator	NIC	O/O	E	F	54"Lx30"Wx79"H	VWR	GDM-49	Double Doors
BE-28	Stratalinker - 400	NIC	O/O	E	B	24"Lx16"Wx11"H	Stratagene	Cat # 40075	Not Located
BE-29	Stratalinker - 1800	NIC	O/O	E	B	19"Lx9"Wx11"H	Stratagene		Not Located
BE-31	Glassware Washer	NIC	O/O	E	F	25"Lx27"Wx37"H	Labconco	4400330	Undercounter
BE-33	Water Bath	NIC	O/O	N	B	15"Lx16"Wx14"H	Fisher Isotemp	210	Not Located
BE-34	Hot Stir Plate	NIC	O/O	E	B	9"Lx14"Wx4"H	Barnstead	SP 131325	Not Located
BE-35	Refrigerator	NIC	O/O	E	F	54"Lx35"Wx84"H	Aegis	1-R3G-48-BCH	Double Doors
BE-36	Spec 20	NIC	O/O	E	B	16"Lx13"Wx9"H	Thermolyne	Spec 20 D	Not Located
BE-37	Spec 20	NIC	O/O	N	B	16"Lx13"Wx9"H	Thermolyne	Spec 20 D	Not Located
BE-38	Refrigerator	NIC	O/O	E	F	59"Lx34"Wx83"H	Traulsen	RHT2-32WUT	Double Metal Doors
BE-39	Explosion Proof Refrigerator	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
BE-40	Acid / Base Storage Cabinets	NIC	O/O	E	F	32"Lx24"Wx22"H	Justrite	5L25624L	Not Located
BE-41	Metal Micro Cabinets	NIC	O/O	E	F	36"Lx15"Wx67"H			Not Located
BE-42	Refrigerator	NIC	O/O	E	F	54"Lx30"Wx79"H	VWR	GDM-49	Double Doors
BE-43	Autoclave	116100	C/C	N	F	28"Lx34"Wx74"H	Getinge	GE-633LS	W/ integral steam generator
BE-44	Laser Printer	NIC	O/O	N	B				Not Located
BE-45	Goggle Cabinet	NIC	O/O	N	W				
BE-46	Incubator	NIC	O/O	N	F	46"L	Labline Imperial	Double Doors	Double Stacked
BE-47	Incubator	NIC	O/O	E	F	46"L	Labline Imperial	Double Doors	Double Stacked
BE-48	DI Water Polisher	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
BE-49	Exhaust Canopy	Div.23	C/C	N	C				See MEP Dwgs & Specs
BE-50	(37º C) Incubator	NIC	O/O	N	F				Double Stacked
BE-51	(-20º) Freezer	NIC	O/O	N	F	30"Lx34"Wx78"H	VWR-Thermo	ULT1340-9-A	
BE-52	Controlled Environmental Room	130390	C/C	N	F		Thermmax	(4º C) Cold Room	Air Cooled Condensing Unit
BE-53	4º C Storage Refrigerator	NIC	O/O	N	F				
BE-54	Media Jet	NIC	O/O	N	F	25"Lx26"Wx13"H	Integra	MediaJet	
BE-55	Media Clave	NIC	O/O	N	F	25"Lx22"Wx19"H	Integra	MediaClave 10	
BE-56	Media Prep.	NIC	C/C	N	F	22"Lx26"Wx21"H	Systec	MediaPrep-10	

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
TE-01	Microscope	NIC	O/O	E	B	9"Lx18"Wx19"H	Nikon	TMS-F	Not Located
TE-02	Autoclave	NIC	O/O	E	B	23"Lx22"Wx15"H	Tuttnauer Brinkmann	2340M	Not Located
TE-03	Centrifuge	NIC	O/O	E	B	32"Lx23"Wx13"H	Sorvall	RT6000B	Not Located
TE-04	Rotator	NIC	O/O	E	B	13"Lx14"Wx16"H	Boekel	Ocelot	Not Located
TE-05	Centrifuge	NIC	O/O	E	B	16"Lx26"Wx16"H	Beckman	GS15R	Not Located
TE-06	Drawers	NIC	O/O	E	F	15"Lx18"Wx50"H			Not Located
TE-07	Drawers on Wheels	NIC	O/O	E	F	10"Lx18"Wx26"H			Not Located
TE-08	Incubator	NIC	O/O	E	B	28"Lx27"Wx36"H	Lab-Line	490NS	Not Located
TE-09	Drawers Cart	NIC	O/O	E	F	16"Lx17"Wx50"H			Not Located
TE-10	Drawers	NIC	O/O	E	F	15"Lx17"Wx42"H			Not Located
TE-11	Water Purification System	NIC	O/O	E		17"Lx14"Wx19"H	Elga	Ultra Genetic	May not be used!
TE-12	Rotator	NIC	O/O	E	B	24"Lx11"Wx12"H	Hybaid	Rotator HR-RI	Not Located
TE-13	Rotator	NIC	O/O	E	B	10"Lx10"Wx5"H	SARSTDT	TPM-2	Not Located
TE-14	Roller Bottle Apparatus	NIC	O/O	E	B	12"Lx11"Wx14"H	Wheaton		
TE-15	Titer plate Shaker	NIC	O/O	E	B	11"Lx11"Wx8"H	Lab-Line	4625	Not Located
TE-16	Stirrer	NIC	O/O	E	B	19"Lx16"Wx7"H	Lab-Line	Multi Stirrer Mistral	Not Located
TE-17	Vacuum Pressure	NIC	O/O	E	B	8"Lx5"Wx9"H	Barnant Company	400-3910	Not Located
TE-18	Drawers	NIC	O/O	E	F	15"Lx17"Wx51"H			Not Located
TE-19	Drawers	NIC	O/O	E	F	15"Lx18"Wx26"H			Not Located
TE-20	Plate Reader	NIC	O/O	E	B	18"Lx19"Wx10"H	BMG Labs	Fluoster	Not Located
TE-21	Incubator	NIC	O/O	E	F	22"Lx22"Wx94"H	Precision		Not Located
TE-22	(-20º) Freezer	NIC	O/O	E	F	32"Lx31"Wx71"H	Kenmore		
TE-23	AKTA-FPLC	NIC	O/O	E	B	17"Lx19"Wx19"H	GE Healthcare	UPC 900	Not Located
TE-24	Fraction Collector	NIC	O/O	E	B	16"Lx19"Wx16"H	GE Healthcare	FRAC950	Not Located
TE-25	Refrigerator	NIC	O/O	E	F	23"Lx21"Wx58"H	Kenmore	363	
TE-26	Microcentrifuge	NIC	O/O	E	B	8"Lx11"Wx11"H	Eppendorf Brickmann	5415C	Not Located
TE-27	Shelves	NIC	O/O	E	F	28"Lx17"Wx68"H			Not Located
TE-28	Multi Image Light	NIC	O/O	E	F	20"Lx14"Wx37"H	Alpha Innotech		Not Located
TE-29	Printer	NIC	O/O	E	B		Alpha Innotech-Seiko	DVP 1200	Not Located
TE-30	Bioreactor	NIC	O/O	E	B	15"Lx15"Wx22"H	Minifors-Infors HT		Not Located
TE-31	Plate Shaker	NIC	O/O	E	B	11"Lx11"Wx8"H	Lab-Line	4625	Not Located
TE-32	Microscope	NIC	O/O	E	B	9"Lx24"Wx22"H	Motic	AE31	Not Located

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
TE-33	Cabinet	NIC	O/O	E	F	36"Lx21"Wx72"H			Not Located
TE-34	Spectrophotometer	NIC	O/O	E	B	18"Lx20"Wx9"H	Bio Rad	Benchmark Plus Microplate Spec.	Not Located
TE-35	Refrigerator	NIC	O/O	E	F	24"Lx24"Wx34"H			Not Located
TE-36	Refrigerator	NIC	O/O	E	F	30"Lx29"Wx66"H	Whirlpool	ET18NKXFWB2	Not Located
TE-37	Roller Bottle Apparatus - Small	NIC	O/O	E	B	13"Lx13"Wx13"H	Wheaton		Not Located
TE-38	Bottle Roller	NIC	O/O	E	B	15"Lx15"Wx4"H	Sorvall Life Science	Roll 115	Not Located
TE-39	Spectrophotometer	NIC	O/O	E	B	13"Lx13"Wx6"H	Bio Rad	Smart Spec 3000	Not Located
TE-40	Balance	NIC	O/O	E	B	10"Lx14"Wx4"H	Denver Inst. Co.	603D	Not Located
TE-41	Vortex	NIC	O/O	E	B	5"Lx6"Wx7"H	Scientific Industries	Genie-2-G-560	Not Located
TE-42	Speed Vac	NIC	O/O	E	B	12"Lx12"Wx10"H	Savent		Not Located
TE-43	Agorose Gel Box	NIC	O/O	E	B	8"Lx11"Wx4"H	Bio Rad	Sub-Cell GT Wide Mini	Not Located
TE-44	Agorose Gel Box	NIC	O/O	E	B	11"Lx5"Wx5"H	Bio Rad	Sub-Cell GT Mini	Not Located
TE-45	Thermocycler	NIC	O/O	E	B	13"Lx24"Wx8"H	Perkin Elmer	Gene AMP 2400	Not Located
TE-46	Power Supply	NIC	O/O	E	B	9"Lx6"Wx5"H	Fotodyne		Not Located
TE-47	Power Supply	NIC	O/O	E	B	13"Lx13"Wx6"H	Gibco BRL Technologies	4001	Not Located
TE-48	Heat Block	NIC	O/O	E	B	8"Lx10"Wx4"H	Thermolyne	Type 17600 Dry Bath	Not Located
TE-49	Vacuum Pressure	NIC	O/O	E	B	8"Lx5"Wx9"H	Barnant Company	400-3910	Not Located
TE-50	Gel Dryer	NIC	O/O	E	B	22"Lx18"Wx5"H	Bio Rad	583	Not Located
TE-51	Voltage Booster	NIC	O/O	E	B	7"Lx12"Wx8"H	BRL		Not Located
TE-52	Cell Porater	NIC	O/O	E	B	10"Lx8"Wx7"H	Gibco BRL Technologies	1613 Series	Not Located
TE-53	Cell Porater	NIC	O/O	E	B	6"Lx12"Wx6"H	BRL	1600 Series	Not Located
TE-54	Explosion Proof Refrigerator	NIC	O/O	E	F	24"Lx23"Wx71"H	Revco / VWR		To Be Replaced??
TE-55	Water Bath	NIC	O/O	E	B	26"Lx15"Wx14"H	Precision	Dual Chamber 188	Not Located
TE-56	Shaker	NIC	O/O	E	B	18"Lx28"Wx19"H	New Brunswick	G24 Environmental Incubator Shaker	Not Located
TE-57	Incubator	NIC	O/O	E	B	16"Lx17"Wx17"H	Elconap Lab Apparatus		Not Located
TE-58	Agorose Gel Box	NIC	O/O	E	B	8"Lx11"Wx5"H	Bio Rad	Sub-Cell GT Wide Mini	Not Located

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
TE-59	Spectrophotometer	NIC	O/O	E	B	13"Lx11"Wx6"H	Bio Rad	Smart Spec 3000	Not Located
TE-60	Vortex	NIC	O/O	E	B	5"Lx6"Wx7"H	VWR	K-550-G	Not Located
TE-61	Vortex	NIC	O/O	E	B	5"Lx7"Wx8"H	Thermolyne	MAXI-MIX11	Not Located
TE-62	Balance	NIC	O/O	E	B	9"Lx14"Wx4"H	Denver Inst. Co.	TR 603D	Not Located
TE-63	Balance	NIC	O/O	E	B	9"Lx14"Wx4"H	Fox Scientific	XR-603D	Not Located
TE-64	Microcentrifuge	NIC	O/O	E	B	8"Lx11"Wx11"H	Eppendorf	5412X1, 5415X1, 5415CX2	Not Located
TE-65	Stirrer Hot Plate	NIC	O/O	E	B	8"Lx8"Wx5"H	Thermolyne	SP46925	Not Located
TE-66	Stirrer Hot Plate	NIC	O/O	E	B	8"Lx8"Wx4"H	Corning	PC-320	Not Located
TE-67	Agarose Gel Box	NIC	O/O	E	B	5"Lx10"Wx5"H	Bio Rad	Sub Cell GT Mini	Not Located
TE-68	Stirrer Hot Plate	NIC	O/O	E	B	11"Lx8"Wx4"H	Thermolyne	SP18425	Not Located
TE-69	Stirrer Hot Plate	NIC	O/O	E	B	8"Lx6"Wx5"H	Corning	PC-3310	Not Located
TE-70	Vortex	NIC	O/O	E	B	5"Lx6"Wx7"H	Fisher	Genie 2 G-560	Not Located
TE-71	BioSafety Cabinet	NIC	O/O	E	F	38"Lx26"Wx86"H	Labconco	Purifier Class II	Not Located
TE-72	Heat Block	NIC	O/O	E	B	8"Lx10"Wx4"H	Thermolyne	1700 Dry Bath	Not Located
TE-73	Balance	NIC	O/O	E	B	9"Lx12"Wx4"H	Sartorius		Not Located
TE-74	Power Supply	NIC	O/O	E	B	9"Lx11"Wx4"H	Bio Rad	Power Pac 200	Not Located
TE-75	UV Transiluminator	NIC	O/O	E	B	9"Lx8"Wx7"H	Fotodyne	1430	Not Located
TE-76	DI Water Polisher	NIC	O/O	E	W	23"Lx14"Wx24"H	Barnstead	NANOpure	To Be Replaced??
TE-77	Microwave Oven	NIC	O/O	E	B	24"Lx18"Wx16"H	Kenmore	99901	Not Located
TE-78	pH Meter	NIC	O/O	E	B	10"Lx10"Wx13"H	Accumet	AB15	Not Located
TE-79	Colony Counter	NIC	O/O	E	B	11"Lx10"Wx12"H	Leica	3325	Not Located
TE-80	Fluorometer	NIC	O/O	E	B	9"Lx11"Wx7"H	Hoeter	DNA Fluorometer TK0100	Not Located
TE-81	Platform	NIC	O/O	E	B	16"Lx14"Wx7"H	Labline	4361R	Not Located
TE-82	Spectro Fluorometer	NIC	O/O	E	B	15"Lx16"Wx7"H	Tecan Spectra Fluor		Not Located
TE-83	Spectrophotometer	NIC	O/O	E	B	19"Lx23"Wx9"H	Milton Roy	Spectronic Genesys 5	Not Located
TE-84	(-80º) Freezer	NIC	O/O	E	F	72"Lx31"Wx42"H	Revco	ULT 1490	Not Located
TE-85	Homogenizer	NIC	O/O	E	B	3"Lx5"Wx18"H	IKA Labor Technik		Not Located
TE-86	Digital Ionalyzer	NIC	O/O	E	B	10"Lx6"Wx6"H	Orion Research	501	Not Located
TE-87	Plate Reader	NIC	O/O	E	B	14"Lx16"Wx9"H	Dynex	MRX Revolation	Not Located
TE-88	Cabinet	NIC	O/O	E	F	47"Lx16"Wx83"H			Not Located
TE-89	Light Box	NIC	O/O	E	B	13"Lx10"Wx4"H	VWR		Not Located

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
TE-90	Page Box	NIC	O/O	E	B	7"Lx5"Wx7"H	Bio Rad	Mini-Transblot	Not Located
TE-91	(-80º) Freezer	NIC	O/O	E	F	35"Lx26"Wx21"H	Revco	ULT 185-5-A12	Not Located
TE-92	Hybridization Oven	NIC	O/O	E	B	15"Lx10"Wx22"H	Techne	Hybridizer HB-1D	Not Located
TE-93	Cold Box	NIC	O/O	E	F	28"Lx35"Wx79"H			Not Located
TE-94	Fraction Collector	NIC	O/O	E	B	10"Lx16"Wx16"H	Spectra/CHROM	CF-1	Not Located
TE-95	Power Supply	NIC	O/O	E	B	11"Lx12"Wx5"H	Bio Rad	Power Pac 1000	Not Located
TE-96	Power Supply	NIC	O/O	E	B	13"Lx10"Wx6"H	E-C-Apparatus	Series 90	Not Located
TE-97	Power Supply	NIC	O/O	E	B	16"Lx10"Wx8"H	BRL	4000	Not Located
TE-98	Stirrer Hot Plate	NIC	O/O	E	B	11"Lx7"Wx4"H	Thermolyne	NUOVA II	Not Located
TE-99	Microfuge	NIC	O/O	E	B	9"Lx12"Wx8"H	Hevaeus	Biofuge Pico	Not Located
TE-100	Power Supply	NIC	O/O	E	B	7"Lx12"Wx5"H	Bio Rad	1000 / 500	Not Located
TE-101	Power Supply	NIC	O/O	E	B	8"Lx12"Wx3"H	Bio Rad	Power Pac 200	Not Located
TE-102	Power Supply	NIC	O/O	E	B	11"Lx12"Wx5"H	Bio Rad	Power Pac 3000	Not Located
TE-103	2-D Gel Box	NIC	O/O	E	B	9"Lx6"Wx8"H	Bio Rad	Criterton	Not Located
TE-104	Vortex	NIC	O/O	E	B	5"Lx6"Wx7"H	VWR	Vortexer 2 G-560	Not Located
TE-105	Balance	NIC	O/O	E	B	9"Lx12"Wx9"H	Mettler Toledo	PB 303-S	Not Located
TE-106	Mixer	NIC	O/O	E	B	6"Lx5"Wx7"H	Laboraft	259-490	Not Located
TE-107	Balance	NIC	O/O	E	B	8"Lx12"Wx3"H	Mettler Toledo	PB 1502	Not Located
TE-108	Line Cinditioner	NIC	O/O	E	B	8"Lx7"Wx6"H	Tripplite	LC 1800	Not Located
TE-109	Stirrer	NIC	O/O	E	B	8"Lx8"Wx4"H	Corning	PC-318	Not Located
TE-110	Transblot	NIC	O/O	E	B	15"Lx10"Wx5"H	Bio Rad	SD Semi Dry	Not Located
TE-111	Water Bath	NIC	O/O	E	B	8"Lx10"Wx8"H	Precision	181	Not Located
TE-112	Gel Box	NIC	O/O	E	B	14"Lx8"Wx14"H	Bio Rad	Protean 11XI Cell	Not Located
TE-113	Microwave Oven	NIC	O/O	E	B	21"Lx15"Wx12"H	Kenmore	721.6828	Not Located
TE-114	Water Bath	NIC	O/O	E	B	16"Lx20"Wx11"H	Baxter		Not Located
TE-115	Balance	NIC	O/O	E	B	8"Lx8"Wx16"H	Sartorius	Handy	Not Located
TE-116	Heat Block	NIC	O/O	E	B		VWR		Not Located
TE-117	Fraction Collector	NIC	O/O	E	B	11"Lx6"Wx13"H	Gilson	Microfractionator	Not Located
TE-118	Vortex	NIC	O/O	E	B	5"Lx11"Wx3"H	VWR IKA	Minivortexer MVI	Not Located
TE-119	Transblot Cell	NIC	O/O	E	B	7"Lx5"Wx6"H	Bio Rad	Mini Transblot	Not Located
TE-120	Oven	NIC	O/O	E	B	11"Lx15"Wx12"H	Organon Teknika	OTC 100	Not Located
TE-121	Fraction Collector	NIC	O/O	E	B	14"Lx13"Wx14"H	Advantec	SF-2120	Not Located
TE-122	Stirrer	NIC	O/O	E	B		Thermolyne	Type 7200	Not Located
TE-123	Vortex	NIC	O/O	E	B	5"Lx7"Wx7"H	Fisher	Genie 2 G-560	Not Located
TE-124	Stirrer	NIC	O/O	E	B	9"Lx10"Wx5"H	Fisher		Not Located

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
TE-125	Heat Block	NIC	O/O	E	B	8"Lx12"Wx4"H	VWR	Heat Block II	Not Located
TE-126	Heat Block	NIC	O/O	E	B	8"Lx6"Wx4"H	Curtin Matheson		Not Located
TE-127	Stirrer	NIC	O/O	E	B	7"Lx11"Wx4"H	VWR	300	Not Located
TE-128	Stirrer	NIC	O/O	E	B	12"Lx8"Wx4"H	Thermolyne	NUOVA II	Not Located
TE-129	Shaking Water Bath	NIC	O/O	E	B	23"Lx13"Wx11"H	GCA Corp.		Not Located
TE-130	Water Bath	NIC	O/O	E	B	16"Lx23"Wx24"H	New Brunswick	G76	Not Located
TE-131	Spectrophotometer	NIC	O/O	E	B	6"Lx20"Wx12"H	Waters	481	Not Located
TE-132	Vacuum Oven	NIC	O/O	E	B	14"Lx17"Wx21"H	Lab Line	N 7595-1	Not Located
TE-133	Shelves	NIC	O/O	E	F	48"Lx19"Wx84"H			Not Located
TE-134	Shelves	NIC	O/O	E	F	24"Lx11"Wx84"H			Not Located
TE-135	Shelves	NIC	O/O	E	F	30"Lx12"Wx59"H			Not Located
TE-136	Shelves	NIC	O/O	E	F	35"Lx18"Wx74"H			Not Located
TE-137	Shelves	NIC	O/O	E	F	28"Lx18"Wx68"H			Not Located
TE-138	Cart	NIC	O/O	E	F	25"Lx40"Wx33"H			Not Located
TE-139	Gear Pump Drive	NIC	O/O	E	B	7"Lx13"Wx6"H			Not Located
TE-140	HPLC	NIC	O/O	E	B	15"Lx17"Wx14"H	Waters	WISP 710B	Not Located
TE-141	Solvent Delivery System	NIC	O/O	E	B	11"Lx11"Wx9"H	Waters	510	Not Located
TE-142	Gradient Controller	NIC	O/O	E	B	12"Lx21"Wx8"H	Waters		Not Located
TE-143	Data Module (FPLC)	NIC	O/O	E	B	20"Lx19"Wx7"H	Waters	730	Not Located
TE-144	Automated Workstation - Part 2	NIC	O/O	E	B	20"Lx18"Wx9"H	Beckman	Biomek 1000	Not Located
TE-145	Automated Workstation - Part 1	NIC	O/O	E	B	29"Lx16"Wx25"H	Beckman	Biomek 1000	Not Located
TE-146	Microcentrifuge	NIC	O/O	E	B	10"Lx10"Wx9"H	Fisher Scientific	235A	Not Located
TE-147	Hot Plate Stirrer	NIC	O/O	E	B	8"Lx6"Wx5"H	Corning	PC-351	Not Located
TE-148	Water Bath	NIC	O/O	E	B	9"Lx10"Wx13"H	Lab-Line	273-807	Not Located
TE-149	BioSafety Cabinet	NIC	O/O	E	F	74"Lx29"Wx86"H	Labconco	36213	Not Located
TE-150	BioSafety Cabinet	NIC	O/O	E	F	78"Lx32"Wx90"H	Thermo Forma	1286	Not Located
TE-151	Incubator	NIC	O/O	N	F	25"Lx24"Wx82"H	Forma	3326	Not Located
TE-152	Stirring Hot Plate	NIC	O/O	N	B	8"Lx10"Wx6"H	Allied-Fisher Scientific	310T	Not Located
TE-153	Heat Block	NIC	O/O	E	B	8"Lx6"Wx4"H	VWR		Not Located
TE-154	pH Meter	NIC	O/O	E	B	8"Lx6"Wx4"H	Accumet	AB15	Not Located
TE-155	Incubator	NIC	O/O	E	B	25"Lx25"Wx39"H	VWR	2200	Not Located
TE-156	Incubator	NIC	O/O	E	B	32"Lx32"Wx43"H	Forma	3860	Not Located
TE-157	Portable Autoclave	NIC	O/O	E	F	20"Lx22"Wx45"H	Tomy	SS-325E	
TE-158	Centrifuge	NIC	O/O	E	B	18"Lx27"Wx15"H	IEC	Centra MP4R	Not Located

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
TE-159	Refrigerator	NIC	O/O	E	F	30"Lx32"Wx60"H	Lab-Line		Not Located
TE-160	BioSafety Cabinet	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	
TE-161	BioSafety Cabinet	123450	C/C	N	F	78"Lx33"Wx95"H	NuAire	NU-425-600	
TE-162	CO2 Incubator	NIC	O/O	N	F	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
TE-163	Fluorescent Microscope	NIC	O/O	N	B				
TE-164	Portable Autoclave	NIC	O/O	N	F	20"Lx22"Wx45"H	Tomy	SX-300 / SX-500	
TE-165	DI Water Polisher	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
TE-166	Refrigerator	NIC	O/O	N	F				
TE-167	(-80º) Freezer	NIC	O/O	N	F	36"Lx35"Wx78"H	NuAire	NU-9483GC	
TE-168	(-150º) Freezer	NIC	O/O	N	F	58"Lx29"Wx43"H	Revco	ULT7150-9-D	
TE-169	(4º C) Storage Refrigerator	NIC	O/O	N	F	36"Lx34"Wx69"H	VWR	13501-926	
TE-170	Chest Freezer	NIC	O/O	N	F	49"Lx29"Wx41"H	VWR-Thermo	14228-576	
TE-171	(-20º) Freezer	NIC	O/O	N	F	30"Lx34"Wx78"H	VWR-Thermo	ULT1340-9-A	
TE-172	Refrigerated Centrifuge	NIC	O/O	N	F				
TE-173	Pass Through Box	116100	C/C	N	W	24"Lx24"Wx24"H	Terra Universal	2636-06C	with 6705-16 clean sloping top & Interlock doors
TE-174	***NOT USED***								
TE-175	Centrifuge	NIC	O/O	N	F				
TE-176	Hamper	NIC	O/O	N	F	31"Lx15"Wx42"H	Terra Universal	5151-51	
TE-177	Dry Ice Box	NIC	O/O	N	F				
TE-178	Gel Imager	NIC	O/O	N	B				
TE-179	Gel Dryer	NIC	O/O	N	B				
TE-180	Speed Vac	NIC	O/O	N	B				
TE-181	Explosion Proof Refrigerator	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
TE-182	Confocal Microscope	NIC	O/O	N	B				
TE-183	FACS	NIC	O/O	N	B				
TE-184	LC Mass	NIC	O/O	N	B				
TE-185	Microarray Scanner	NIC	O/O	N	B				
TE-186	Autoclave	116100	C/C	N	F	28"Lx34"Wx74"H	Getinge	GE-633LS	W/ Integral steam generator
TE-187	Exhaust Canopy	Div.23	C/C	N	C				
TE-188	Ice Maker	116500	C/C	N	F	30"Lx34"Wx72"H	Scotsman	FME504AS-1A	with HTB555-H Storage Bin
TE-189	Glassware Washer	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
TE-190	Drying Oven	NIC	O/O	E	B	24"Lx24"Wx49"H	VWR	1327F	

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
TE-191	(-20º) Freezer	NIC	O/O	N	F				
TE-192	(-80º) Freezer	NIC	O/O	N	F				
TE-193	***NOT USED***								
TE-194	Refrigerator / Freezer	NIC	O/O	N	F	24"Lx25"Wx35"H	VWR	82028-016	Undercounter
TE-195	Recirculating Chiller	NIC	O/O	N	E	14"Lx25"Wx28"H	Thermo Scientific	ThermoFlex 1400	
TE-196	Laser Printer	NIC	O/O	N	B				
TE-197	Incubator / Shaker	NIC	O/O	N	F	42"Lx34"Wx46"H	ATR (Infors HT)	Minitron or Multitron II	Double Stacked
TE-198	Washer	NIC	O/O	N	F	29"Lx27"Wx46"H	LG	WT5001CW	
TE-199	Dryer	NIC	O/O	N	F	29"Lx27"Wx46"H	LG	DL5001W	
TE-200	Fermentation System	NIC	O/O	N	E	25"Lx24"Wx34"H	New Brunswick Scientific	BioFlo 310	
TE-201	Plate Pourer	NIC	O/O	N	B				
TE-202	Q.P.C.R.	NIC	O/O	N	B				

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
CE-01	Hot Plate	NIC	O/O	E	B	7"Lx7"Wx5"H	Corning	PC200	Not Located
CE-02	Hot Plate	NIC	O/O	E	B	8"Lx12"Wx4"H	Fisher		Not Located
CE-03	Hot Plate	NIC	O/O	E	B	7"Lx7"Wx6"H	VWR	986972	Not Located
CE-04	Hot Plate	NIC	O/O	N	B	7"Lx7"Wx6"H	VWR	986972	Not Located
CE-05	Analytical Balance	NIC	O/O	N	B		Mettler Toledo	XP504	
CE-06	Analytical Balance	NIC	O/O	E	B	8"Lx17"Wx13"H	Fisher / Denver	EMD-310	Defective. Replace w/ CE-05
CE-07	Water Bath	NIC	O/O	E	B	14"Lx20"Wx14"H	VWR	1203	Not Located
CE-08	Water Bath	NIC	O/O	N	B	14"Lx20"Wx14"H	VWR	1203	Not Located
CE-09	Water Bath	NIC	O/O	E	B	15"Lx18"Wx14"H	Precision	184	Defective. Replace w/ CE-08
CE-10	Centrifuge	NIC	O/O	E	B		VWR	Clinical 100	Not Located
CE-11	Centrifuge	NIC	O/O	N	B		VWR	Clinical 100	Not Located
CE-12	pH Meter	NIC	O/O	E	B	12"Lx12"Wx12"H	Corning	430	Not Located
CE-13	pH Meter	NIC	O/O	E	B	12"Lx12"Wx12"H	Corning	M530P/530	Not Located
CE-14	pH Meter	NIC	O/O	E	B	12"Lx12"Wx12"H	Corning	215	Fair / Poor Condition
CE-15	Stir Plate	NIC	O/O	E	B		Fisher	11-510-165-B	Not Located
CE-16	Vortex Mixer	NIC	O/O	E	B	5"Lx7"Wx7"H	Fisher	G-560	Not Located
CE-17	Vortex Mixer	NIC	O/O	N	B	5"Lx7"Wx7"H	Fisher	G-560	Not Located
CE-18	Spectronic 20/20+	NIC	O/O	E	B	16"Lx13"Wx9"H	Thermo	Spectronic 20/20+	7 Fair, 3 Defective.
CE-19	Spectronic 20/20+	NIC	O/O	N	B	16"Lx13"Wx9"H	Thermo	Spectronic 20/20+	Not Located
CE-20	Geiger Counter	NIC	O/O	E	B	12"Lx8"Wx4"H	Daedalon Corp.	EN-15	Not Located
CE-21	Magnetizer	NIC	O/O	E	B	12"Lx4"Wx6"H	Electro-Technic Products Inc.	28000	Not Located
CE-22	Analytical Balance	NIC	O/O	E	B	8"Lx14"Wx14"H	Mettler Toledo	PG 503	Not Located
CE-23	Induction Coil	NIC	O/O	E	B	18"Lx14"Wx10"H	Seargent Welch	S68755	Not Located
CE-24	Power Supply	NIC	O/O	N	B	8"Lx7"Wx5"H	Central Scientific	33031	Not Located
CE-25	Ice Maker	116500	C/C	N	F	30"Lx34"Wx72"H	Scotsman	FME504AS-1A	with HTB555-H Storage Bin
CE-26	Glassware Washer	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
CE-27	Laser Printer	NIC	O/O	N	B				
CE-28	Rolled-Up Periodic Table	NIC	O/O	N	C	58"Lx42"H	Fisher Scientific	S45525A	With spring roller
CE-29	NMR	NIC	O/O	E	F	79"Lx79"W	Jeol	JNM-MY60	Will be replaced w/ CE-70
CE-30	GC Plotter	NIC	O/O	E	B	14"Lx15"Wx6"H	Gow-Mac	70-150	Not Located
CE-31	GC	NIC	O/O	E	B	12"Lx18"Wx17"H	Gow-Mac	Series 350	
CE-32	UV Light Box	NIC	O/O	E	B	10"Lx9"Wx10"H	UVP Inc.	UVG-54	Not Located
CE-32	UV Light Box	NIC	O/O	E	B	10"Lx9"Wx10"H	UVP Inc.	UVG-54	Not Located
CE-33	Water Bath	NIC	O/O	E	B	15"Lx17"Wx15"H	Fisher Isotemp	210	Not Located
CE-34	Water Bath	NIC	O/O	N	B	15"Lx17"Wx15"H	Fisher Isotemp	210	Not Located
CE-35	Stir Plate	NIC	O/O	E	B	5"Lx5"Wx2"H	Hanna	HI200	Not Located
CE-36	Heating Mantle	NIC	O/O	E	B	9"Lx5"Wx2"H	Glas-Col	Series 0	Not Located
CE-37	Heating Mantle	NIC	O/O	N	B	9"Lx5"Wx2"H	Glas-Col	Series 0	Not Located
CE-38	Hood	NIC	O/O	E	B	13"Lx29"Wx54"H	Labconco	69100-00	Not Located
CE-39	Balance	NIC	O/O	E	B	9"Lx12"Wx4"H	Ohaus	AV212C	
CE-40	Balance	NIC	O/O	N	B	9"Lx12"Wx4"H	Ohaus	AV212C	
CE-41	Balance	NIC	O/O	E	B	8"Lx14"Wx8"H	Scientech	SP250	
CE-42	Analytical Balance	NIC	O/O	E	B	15"Lx10"Wx14"H	Ainsworth	PI314A	
CE-43	Analytical Balance	NIC	O/O	N	B	15"Lx10"Wx14"H	Ainsworth	PI314A	
CE-44	Explosion Proof Hot Plate	NIC	O/O	E	B	8"Lx7"Wx4"H		HP 11500B	Hard wired inside fume hood
CE-45	Melting Point	NIC	O/O	E	B	5"Lx6"Wx13"H	Barnstead	1401	Not Located
CE-46	Melting Point	NIC	O/O	E	B	7"Lx13"Wx10"H	Stanford	OPTIMELT	Not Located
CE-47	Melting Point	NIC	O/O	N	B	7"Lx13"Wx10"H	Stanford	OPTIMELT	Not Located
CE-48	Mini Hot Plates	NIC	O/O	E	B	5"Lx7"Wx6"H	VWR	986972	Not Located
CE-49	Mini Hot Plates	NIC	O/O	N	B	5"Lx7"Wx6"H	VWR	986972	Not Located
CE-50	Refractometer	NIC	O/O	E	B	6"Lx13"Wx14"H	Thermo	334610	Not Located
CE-51	Refractometer	NIC	O/O	N	B	9"Lx12"Wx3"H	Reichert		Not Located

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
CE-52	Polarimeter	NIC	O/O	E	B	15"Lx6"Wx13"H	Linos, Polyscience	SR6	1 poor, Replace w/ CE-53
CE-53	Polarimeter	NIC	O/O	N	B	25"Lx13"Wx18"H	Rudolph Autopol II		Not Located
CE-54	Variac	NIC	O/O	E		6"Lx8"Wx6"H	Staco	3PN 10101B	
CE-55	Variac	NIC	O/O	N		6"Lx8"Wx6"H	Staco	3PN 10101B	
CE-56	Sand Bath	NIC	O/O	E	B	5"Lx5"Wx3"H	Laboratory Craftsman	100ML C3AM	Not Located
CE-57	Sand Bath	NIC	O/O	N	B	5"Lx5"Wx3"H	Laboratory Craftsman	100ML C3AM	Not Located
CE-58	***NOT USED***								
CE-59	Refrigerator	NIC	O/O	E	F	30"Lx35"Wx60"H	Lab-Line	3551/3559	
CE-60	Hot Plate / Stirrer	NIC	O/O	E	B	8"Lx8"Wx5"H	Cimarec / Barnstead	SP46925	Not Located
CE-61	Hot Plate / Stirrer	NIC	O/O	N	B	8"Lx8"Wx5"H	Cimarec / Barnstead	SP46925	Not Located
CE-62	***NOT USED***								
CE-63	***NOT USED***								
CE-64	Balance	NIC	O/O	E	B	7"Lx13"Wx7"H	Ohaus	GT410	Poor. Replace w/ CE-65
CE-65	Balance	NIC	O/O	N	B		Mettler Toledo	XP204	Not Located
CE-66	Oven	NIC	O/O	N	B	24"Lx22"Wx28"H	VWR	52352-094	
CE-67	FT-IR	NIC	O/O	N	B	21"Lx24"Wx12"H	Perkin Elmer	Spectrum 100	Plus PC & Printer for each
CE-68	Snorkel	123450	C/C	N	C		Nederman	FX75	Extractor arms w/ hood
CE-69	Cylinder Support	123400	C/C	N	W		Lab Safety Supply	9417	Bench Mounted
CE-70	NMR 90 MHz Magnet	NIC	O/O	N	F	41"Lx34"Wx34"H	Anasazi	EFT-90	Vibration Sensitive
CE-71	NMR 90 MHz Electronic Cabinet	NIC	O/O	N	F	9"Lx25"Wx26"H	Anasazi	EFT-90	Vibration Sensitive
CE-72	NMR 90 MHz Workstation	NIC	O/O	N	F	36"Lx30"Wx29"H	Anasazi	EFT-90	Vibration Sensitive

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
CE-73	***NOT USED***								
CE-74	Explosion Proof Refrigerator	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
CE-75	***NOT USED***								
CE-76	***NOT USED***								

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
UE-01	Balance	NIC	O/O	N	B	11"Lx20"Wx13"H	Mettler	XP26	Not Located
UE-02	Balance	NIC	O/O	N	B	10"Lx13"Wx10"H	Mettler	PB403-s-FACT	Not Located
UE-03	Refrigerated Centrifuge	NIC	O/O	N	B	26"Lx27"Wx16"H	Beckman Coulter	Alegra 25R	Not Located
UE-04	Centrifuge	NIC	O/O	N	B	16"Lx34"Wx34"H	Beckman Coulter	Avanti J26XP	Not Located
UE-05	Micro Centrifuge	NIC	O/O	N	B	15"Lx23"Wx12"H	Beckman Coulter	22R wF241.5P	Not Located
UE-06	Elisa Reader	NIC	O/O	N	B	14"Lx13"Wx6"H	Bio Rad	168-1001 Model 680	Not Located
UE-07	Flow Cytometer	NIC	O/O	N	B	24"Lx36"Wx25"H	BD Bioscience	BD FACSCanto	Not Located
UE-08	HPLC	NIC	O/O	N	B	36"Lx24"Wx24"H	Waters	Breeze	Not Located
UE-09	BioSafety Cabinet	123450	C/C	N	F	78"Lx33"Wx95"H	NuAire	NU-425-600	
UE-10	Imager Analyzer	NIC	O/O	N	B	23"Lx28"Wx12"H	Bio Rad	170-9450	Not Located
UE-11	Incubator	NIC	O/O	N	B	12"Lx12"Wx36"H	Fisher	11-690-637F	Not Located
UE-12	CO2 Incubator	NIC	O/O	N	B	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
UE-13	Shaking Incubator	NIC	O/O	N	F	46"Lx32"Wx41"H	New Brunswick	Inova 43	Not Located
UE-14	Water Bath	NIC	O/O	N	B	16"Lx15"Wx9"H	Fisher	15-462-10Q	Not Located
UE-15	Thermal Cycler	NIC	O/O	N	B	10"Lx20"Wx10"H	Bio Rad	170-9780	Not Located
UE-16	RealTime PCR	NIC	O/O	N	B	12"Lx24"Wx16"H	Bio Rad	170-9780 iQ5	Not Located
UE-17	pH Meter	NIC	O/O	N	B	5"Lx6"Wx10"H	Mettler	SevenMulti S40	Not Located
UE-18	Power Supply	NIC	O/O	N	B	7"Lx15"Wx5"H	Bio Rad	164-5070	Not Located
UE-19	(-80º) Freezer	NIC	O/O	N	F	36"Lx35"Wx78"H	NuAire	NU-9483GC	
UE-20	Refrigerator	NIC	O/O	N	F	32"Lx52"Wx78"H	Fisher Scientific	13-198-128	Not Located
UE-21	Confocal Microscope	NIC	O/O	N	B	84"Lx120"Wx24"H	Olympus	FV1000-MPE	Vibration Sensitive
UE-22	Dissecting Microscope	NIC	O/O	N	B	11"Lx14"Wx23"H	Olympus	SZX12	Not Located
UE-23	Microscope	NIC	O/O	N	B	10"Lx15"Wx20"H	Olympus	SX31	Not Located
UE-24	Mass Spec	NIC	O/O	N	B	48"Lx24"Wx24"H	Brucker Daltonics	Ultra flex III	Not Located
UE-25	UV Vis Spectrophotometer	NIC	O/O	N	B	15"Lx7"Wx5"H	Bio Rad	170-2525	Not Located
UE-26	DI Water Polisher	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
UE-27	BioSafety Cabinet	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
UE-28	Glassware Washer	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
UE-29	***NOT USED***								
UE-30	Snorkel	123450	C/C	N	C		Nederman	FX75	Extractor arms w/ hood
UE-31	Explosion Proof Refrigerator	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
UE-32	(-20º) Freezer	NIC	O/O	N	F	30"Lx34"Wx78"H	VWR-Thermo	ULT1340-9-A	
UE-33	Centrifuge	NIC	O/O	N	B				
UE-34	Centrifuge	NIC	O/O	N	F				
UE-35	Laser Printer	NIC	O/O	N	B				Not Located
UE-36	Cylinder Support	123400	C/C	N	W		Lab Safety Supply	8446	

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
FH-01	Fume Hood - 4'	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
FH-02	ADA Fume Hood - 4'	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
FH-03	Fume Hood - 6'	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
FH-04	ADA Fume Hood - 6'	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
FH-05	Walk-In Fume Hood - 4'	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Equip No.	Description	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
LE-01a	Computer (Base)	NIC	O/O	E	B	5"Lx22"Wx20"H			Not Located
LE-01b	Monitor & Mouse	NIC	O/O	E	B	27"Lx15"Wx16"H			Not Located
LE-02a	Computer (Base)	NIC	O/O	N	B	5"Lx22"Wx20"H			Not Located
LE-02b	Monitor & Mouse	NIC	O/O	N	B	27"Lx15"Wx16"H			Not Located
LE-03	TV with VCR	NIC	O/O	E	B	20"Lx10"Wx20"H			Not Located
LE-04	TV with VCR	NIC	O/O	N	B	20"Lx10"Wx20"H			Not Located
LE-05	Printer	NIC	O/O	E	B	22"Lx26"Wx25"H			Not Located
LE-06	Printer	NIC	O/O	N	B	22"Lx26"Wx25"H			Not Located
LE-07	Copier	NIC	O/O	N	B	22"Lx26"Wx25"H			Not Located
LE-08	Projector	NIC	O/O	N	B	19"Lx5"Wx14"H			Not Located
LE-09	Microscope	NIC	O/O	E	B	5"Lx6"Wx17"H			Not Located
LE-10	Microscope	NIC	O/O	N	B	5"Lx6"Wx17"H			Not Located
LE-11	Slide Box	NIC	O/O	E	B	3"Lx4"Wx1"H			Not Located
LE-12	Slide Box	NIC	O/O	N	B	3"Lx4"Wx1"H			Not Located
LE-13	Fish Tank	NIC	O/O	E	B	25"Lx20"Wx20"H			Not Located
LE-14	Fish Tank	NIC	O/O	N	B	25"Lx20"Wx20"H			Not Located

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-17	Balance	1	NIC	O/O	N	B	8"Lx14"Wx4"H	Mettler Toledo	XS 2002S	Not Located
SA239	002	Biology Prep Room #4 (Microbio/Genetics)	BE-18	Glassware Washer	1	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-25	Refrigerator	1	NIC	O/O	E	F	54"Lx30"Wx79"H	VWR	GDM-49	Double Doors
SA239	002	Biology Prep Room #4 (Microbio/Genetics)	BE-28	Stratalinker - 400	1	NIC	O/O	E	B	24"Lx16"Wx11"H	Stratagene	Cat # 40075	Not Located
SA239	002	Biology Prep Room #4 (Microbio/Genetics)	BE-29	Stratalinker - 1800	1	NIC	O/O	E	B	19"Lx9"Wx11"H	Stratagene		Not Located
SA239	002	Biology Prep Room #4 (Microbio/Genetics)	BE-33	Water Bath	1	NIC	O/O	N	B	15"Lx16"Wx14"H	Fisher Isotemp	210	Not Located
SA239	002	Biology Prep Room #4 (Microbio/Genetics)	BE-34	Hot Stir Plate	1	NIC	O/O	E	B	9"Lx14"Wx4"H	Barnstead	SP 131325	Not Located
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-43	Autoclave	1	116100	C/C	N	F	28"Lx34"Wx74"H	Getinge	GE-633LS	W/ integral steam generator
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-48	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-49	Exhaust Canopy	1	Div.23	C/C	N	C				See MEP Dwgs & Specs
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-50	(37º C) Incubator	2	NIC	O/O	N	F				Double Stacked
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-53	Refrigerator	1	NIC	O/O	N	F	54"Lx30"Wx79"H	VWR	GDM-49	Double Doors
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-54	Media Jet	1	NIC	O/O	N	F	25"Lx26"Wx13"H	Integra	MediaJet	
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-55	Media Clave	1	NIC	O/O	N	F	25"Lx22"Wx19"H	Integra	MediaClave 10	
	002	Biology Prep Room #4 (Microbio/Genetics)	BE-56	Media Prep	1	NIC	C/C	N	F	22"Lx26"Wx21"H	Systec	MediaPrep-10	
	002	Biology Prep Room #4 (Microbio/Genetics)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	008	Microbiology Lab	BE-05	BioSafety Cabinet	1	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	
	008	Microbiology Lab	BE-07	Refrigerator	2	NIC	O/O	N	F	54"Lx30"Wx79"H	VWR	Serial #1269359 GDM-49	Double Doors
	008	Microbiology Lab	BE-46	Incubator	2	NIC	O/O	N	F	46"L	Labline Imperial	Double Doors	Double Stacked
	008	Microbiology Lab	BE-47	Incubator	2	NIC	O/O	E	F	46"L	Labline Imperial	Double Doors	Double Stacked
	008	Microbiology Lab	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	013	Genetics Lab	BE-09	Refrigerator / Freezer	1	NIC	O/O	N	F	31"Lx30"Wx66"H	Fisher Isotemp	13-986-106A	NEMA 5-15 Plug
	013	Genetics Lab	BE-10	Incubator	2	NIC	O/O	N	B	24"Lx26"Wx27"H	Fisher Isotemp	11-690-525D	Not Located
	013	Genetics Lab	BE-11	Shaker Incubator	1	NIC	O/O	N	F	28"Lx21"Wx20"H	New Brunswick	M1283-000	
	013	Genetics Lab	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	014A	Autoclave Room #2 (Decontamination)	BE-43	Autoclave	1	116100	C/C	N	F	28"Lx34"Wx74"H	Getinge	GE-633LS	W/ integral steam generator
	014A	Autoclave Room #2 (Decontamination)	BE-49	Exhaust Canopy	1	Div.23	C/C	N	C				See MEP Dwgs & Specs
BSMAT	120	Ecology / Environmental Biology Lab	BE-01	Environmental Growth Chamber	2	NIC	O/O	N	F	32"Lx27"Wx72"H	VWR	2015	
BSMAT	120	Ecology / Environmental Biology Lab	BE-02	Wet Lab Table for Aquaria	1	NIC	O/O	N	F	72"Lx24"Wx36"H			
	120	Ecology / Environmental Biology Lab	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	122	Biology Prep Room #2 (General Bio/Eco)	BE-05	BioSafety Cabinet	1	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	
	122	Biology Prep Room #2 (General Bio/Eco)	BE-12	Water Bath	1	NIC	O/O	E	B	32"Lx20"Wx10"H	Equatherm		Not Located
	122	Biology Prep Room #2 (General Bio/Eco)	BE-13	Water Bath	2	NIC	O/O	E	B	14"Lx17"Wx11"H	VWR	1228	Not Located
	122	Biology Prep Room #2 (General Bio/Eco)	BE-14	Water Bath	1	NIC	O/O	E	B	32"Lx20"Wx12"H	Precision	66634	Not Located
	122	Biology Prep Room #2 (General Bio/Eco)	BE-15	Water Bath	1	NIC	O/O	E	B	15"Lx16"Wx14"H	Fisher Isotemp	210	Not Located
	122	Biology Prep Room #2 (General Bio/Eco)	BE-16	Hot Stir Plate	1	NIC	O/O	N	B	9"Lx14"Wx4"H	Barnstead	SP 131325	Not Located
	122	Biology Prep Room #2 (General Bio/Eco)	BE-17	Balance	1	NIC	O/O	N	B	8"Lx14"Wx4"H	Mettler Toledo	XS 2002S	Not Located
	122	Biology Prep Room #2 (General Bio/Eco)	BE-18	Glassware Washer	1	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
	122	Biology Prep Room #2 (General Bio/Eco)	BE-19	Ice Maker	1	116500	C/C	N	F	30"Lx34"Wx72"H	Scotsman	FME504AS-1A	with HTB555-H Storage Bin
	122	Biology Prep Room #2 (General Bio/Eco)	BE-20	Drying Oven	1	NIC	O/O	N	B	24"Lx24"Wx49"H	VWR	1327F	
	122	Biology Prep Room #2 (General Bio/Eco)	BE-21	Refrigerator	1	NIC	O/O	E	F	55"Lx34"Wx84"H	Hobart	32486581	Double Doors
SA240	122	Biology Prep Room #2 (General Bio/Eco)	BE-22	Incubator	1	NIC	O/O	E	F	47"Lx24"Wx37"H	National		Stacked above BE-23

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
SA240	122	Biology Prep Room #2 (General Bio/Eco)	BE-23	Incubator	1	NIC	O/O	E	F	42"Lx21"Wx36"H	Labline Imperial		Located under BE-22
	122	Biology Prep Room #2 (General Bio/Eco)	BE-44	Printer	1	NIC	O/O	N	B				Not Located
	122	Biology Prep Room #2 (General Bio/Eco)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
SA239	122A	Biology Lab Stock Room	BE-36	Spec 20	5	NIC	O/O	E	B	16"Lx13"Wx9"H	Thermolyne	Spec 20 D	Not Located
	122A	Biology Lab Stock Room	BE-37	Spec 20	7	NIC	O/O	N	B	16"Lx13"Wx9"H	Thermolyne	Spec 20 D	Not Located
	122A	Biology Lab Stock Room	BE-38	Refrigerator	1	NIC	O/O	E	F	59"Lx34"Wx83"H	Traulsen	RHT2-32WUT	Double Metal Doors
	122A	Biology Lab Stock Room	BE-39	Explosion Proof Refrigerator	1	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
	122A	Biology Lab Stock Room	BE-40	Acid / Base Storage Cabinets	2	NIC	O/O	E	F	32"Lx24"Wx22"H	Justrite	5L25624L	Not Located
SA240	122A	Biology Lab Stock Room	BE-41	Metal Micro Cabinets	2	NIC	O/O	E	F	36"Lx15"Wx67"H			Not Located
	122A	Biology Lab Stock Room	BE-51	(-20º) Freezer	1	NIC	O/O	N	F	30"Lx34"Wx78"H	VWR-Thermo	ULT1340-9-A	
	125	General Biology Lab #1	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	126	Biology Preservation Room	BE-42	Refrigerator	1	NIC	O/O	E	F	54"Lx30"Wx79"H	VWR	GDM-49	Double Doors
	126	Biology Preservation Room	BE-52	Controlled Environmental Room	1	130390	C/C	N	F		Thermmax	(4º C) Cold Room	Air Cooled Condensing Unit
	126	Biology Preservation Room	BE-53	Refrigerator	1	NIC	O/O	N	F	54"Lx30"Wx79"H	VWR	GDM-49	Double Doors
	127	General Biology Lab #2	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	128	Anatomy & Physiology Lab Recitation	BE-44	Laser Printer	2	NIC	O/O	N	B				Not Located
	130	Biology Prep Room #1 (General Bio)	BE-16	Hot Stir Plate	1	NIC	O/O	N	B	9"Lx14"Wx4"H	Barnstead	SP 131325	Not Located
	130	Biology Prep Room #1 (General Bio)	BE-17	Balance	1	NIC	O/O	N	B	8"Lx14"Wx4"H	Mettler Toledo	XS 2002S	Not Located
	130	Biology Prep Room #1 (General Bio)	BE-18	Glassware Washer	1	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
	130	Biology Prep Room #1 (General Bio)	BE-19	Ice Maker	1	116500	C/C	N	F	30"Lx34"Wx72"H	Scotsman	FME504AS-1A	with HTB555-H Storage Bin
	130	Biology Prep Room #1 (General Bio)	BE-20	Drying Oven	1	NIC	O/O	N	B	24"Lx24"Wx49"H	VWR	1327F	
	130	Biology Prep Room #1 (General Bio)	BE-33	Water Bath	1	NIC	O/O	N	B	15"Lx16"Wx14"H	Fisher Isotemp	210	Not Located
	130	Biology Prep Room #1 (General Bio)	BE-35	Refrigerator	1	NIC	O/O	E	F	54"Lx35"Wx84"H	Aegis	1-R3G-48-BCH	Double Doors
	130	Biology Prep Room #1 (General Bio)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	131	Autoclave Room #1 (Sterilization)	BE-43	Autoclave	1	116100	C/C	N	F	28"Lx34"Wx74"H	Getinge	GE-633LS	W/ integral steam generator
	131	Autoclave Room #1 (Sterilization)	BE-49	Exhaust Canopy	1	Div.23	C/C	N	C				See MEP Dwgs & Specs
	129	Anatomy & Physiology Lab #1	BE-03	EKG Machine	6	NIC	O/O	N	B	11"Lx13"Wx4"H	Burdick	EK10	Not Located
	129	Anatomy & Physiology Lab #1	BE-04	BSL System	3	NIC	O/O	E	B	29"Lx25"Wx7"H	BIOPAC	MP35	Not Located
	129	Anatomy & Physiology Lab #1	BE-45	Goggle Cabinet	1	NIC	O/O	N	W				
	129	Anatomy & Physiology Lab #1	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	132	General Biology Lab #3	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	133	Biology Prep Room #3 (A & P)	BE-15	Water Bath	1	NIC	O/O	E	B	15"Lx16"Wx14"H	Fisher Isotemp	210	Not Located
	133	Biology Prep Room #3 (A & P)	BE-16	Hot Stir Plate	1	NIC	O/O	N	B	9"Lx14"Wx4"H	Barnstead	SP 131325	Not Located
	133	Biology Prep Room #3 (A & P)	BE-17	Balance	1	NIC	O/O	N	B	8"Lx14"Wx4"H	Mettler Toledo	XS 2002S	Not Located
	133	Biology Prep Room #3 (A & P)	BE-18	Glassware Washer	1	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
	133	Biology Prep Room #3 (A & P)	BE-20	Drying Oven	1	NIC	O/O	N	B	24"Lx24"Wx49"H	VWR	1327F	
	133	Biology Prep Room #3 (A & P)	BE-53	Refrigerator	1	NIC	O/O	N	F	54"Lx30"Wx79"H	VWR	GDM-49	Double Doors
	133	Biology Prep Room #3 (A & P)	BE-44	Laser Printer	1	NIC	O/O	N	B				Not Located
	133	Biology Prep Room #3 (A & P)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	134	General Biology Lab Recitation #1	BE-44	Laser Printer	2	NIC	O/O	N	B				Not Located
	135	Plant Growth Room	BE-01	Environmental Growth Chamber	2	NIC	O/O	N	F	32"Lx27"Wx72"H	VWR	2015	
	136	Anatomy & Physiology Lab #2	BE-45	Goggle Cabinet	1	NIC	O/O	N	W				
	136	Anatomy & Physiology Lab #2	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	137	General Biology Lab #4	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	138	Student Project Shared Lab	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	141	General Biology Lab Recitation #2	BE-44	Laser Printer	2	NIC	O/O	N	B				Not Located
	219	BTI Bioscience Lab	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	003	Biotech Lab Prep Room #1 (General Prep)	TE-157	Portable Autoclave	1	NIC	O/O	E	F	20"Lx22"Wx45"H	Tomy	SS-325E	
	003	Biotech Lab Prep Room #1 (General Prep)	TE-160	BioSafety Cabinet	1	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	
	003	Biotech Lab Prep Room #1 (General Prep)	TE-162	CO2 Incubator	1	NIC	O/O	N	F	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
	003	Biotech Lab Prep Room #1 (General Prep)	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	003	Biotech Lab Prep Room #1 (General Prep)	TE-167	(-80º) Freezer	4	NIC	O/O	N	F	36"Lx35"Wx78"H	NuAire	NU-9483GC	
	010	Biotech Lab Stock Room											
	012	Gowning Room	TE-176	Hamper	1	NIC	O/O	N	F	31"Lx15"Wx42"H	Terra Universal	5151-51	
SA240F3	012A	Robotics / Manufacturing Lab - Cell	TE-30	Bioreactor	4	NIC	O/O	E	B	15"Lx15"Wx22"H	Minifors-Infors HT		Not Located
SA240F3	012A	Robotics / Manufacturing Lab - Cell	TE-157	Portable Autoclave	1	NIC	O/O	E	F	20"Lx22"Wx45"H	Tomy	SS-325E	
SA240F3	012A	Robotics / Manufacturing Lab - Cell	TE-158	Centrifuge	1	NIC	O/O	E	B	18"Lx27"Wx15"H	IEC	Centra MP4R	Not Located
SA240F3	012A	Robotics / Manufacturing Lab - Cell	TE-159	Refrigerator	1	NIC	O/O	E	F	30"Lx32"Wx60"H	Lab-Line		Not Located
	012A	Robotics / Manufacturing Lab - Cell	TE-161	BioSafety Cabinet	8	123450	C/C	N	F	78"Lx33"Wx95"H	NuAire	NU-425-600	
	012A	Robotics / Manufacturing Lab - Cell	TE-162	CO2 Incubator	2	NIC	O/O	N	F	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
	012A	Robotics / Manufacturing Lab - Cell	TE-164	Portable Autoclave	1	NIC	O/O	N	F	20"Lx22"Wx45"H	Tomy	SX-300 / SX-500	
	012A	Robotics / Manufacturing Lab - Cell	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	012A	Robotics / Manufacturing Lab - Cell	TE-175	Centrifuge	2	NIC	O/O	N	F				
	012A	Robotics / Manufacturing Lab - Cell	TE-195	Recirculating Chiller	8	NIC	O/O	N	E	14"Lx25"Wx28"H	Thermo Scientific	ThermoFlex 1400	
	012A	Robotics / Manufacturing Lab - Cell	TE-200	Fermentation System	8	NIC	O/O	N	E	25"Lx24"Wx34"H	New Brunswick Scientific	BioFlo 310	
SA240	012B	Robotics / Manufacturing Lab - Media	TE-25	Refrigerator	1	NIC	O/O	E	F	23"Lx21"Wx58"H	Kenmore	363	
	012B	Robotics / Manufacturing Lab - Media	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	012B	Robotics / Manufacturing Lab - Media	TE-173	Pass Through Box	2	116100	C/C	N	W	24"Lx24"Wx24"H	Terra Universal	2636-06C	with 6705-16 clean sloping top & Interlock doors
SA240	012C	Robotics / Manufacturing Lab - Protein	TE-23	AKTA-FPLC	2	NIC	O/O	E	B	17"Lx19"Wx19"H	GE Healthcare	UPC 900	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-24	Fraction Collector	2	NIC	O/O	E	B	16"Lx19"Wx16"H	GE Healthcare	FRAC950	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-26	Microcentrifuge	2	NIC	O/O	E	B	8"Lx11"Wx11"H	Eppendorf Brickmann	5415C	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-27	Shelves	1	NIC	O/O	E	F	28"Lx17"Wx68"H			Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-28	Multi Image Light	1	NIC	O/O	E	F	20"Lx14"Wx37"H	Alpha Innotech		Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-29	Printer	1	NIC	O/O	E	B		Alpha Innotech-Seiko	DVP 1200	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-31	Plate Shaker	1	NIC	O/O	E	B	11"Lx11"Wx8"H	Lab-Line	4625	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-32	Microscope	1	NIC	O/O	E	B	9"Lx24"Wx22"H	Motic	AE31	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-33	Cabinet	1	NIC	O/O	E	F	36"Lx21"Wx72"H			Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-34	Spectrophotometer	1	NIC	O/O	E	B	18"Lx20"Wx9"H	Bio Rad	Benchmark Plus Microplate Spec.	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-35	Refrigerator	1	NIC	O/O	E	F	24"Lx24"Wx34"H			Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-36	Refrigerator	1	NIC	O/O	E	F	30"Lx29"Wx66"H	Whirlpool	ET18NKXFWB2	Not Located

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-37	Roller Bottle Apparatus - Small	3	NIC	O/O	E	B	13"Lx13"Wx13"H	Wheaton		Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-38	Bottle Roller	2	NIC	O/O	E	B	15"Lx15"Wx4"H	Sorvall Life Science	Roll 115	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-39	Spectrophotometer	5	NIC	O/O	E	B	13"Lx13"Wx6"H	Bio Rad	Smart Spec 3000	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-40	Balance	6	NIC	O/O	E	B	10"Lx14"Wx4"H	Denver Inst. Co.	603D	Not Located
SA240F3	012C	Robotics / Manufacturing Lab - Protein	TE-41	Vortex	5	NIC	O/O	E	B	5"Lx6"Wx7"H	Scientific Industries	Genie-2-G-560	Not Located
	012C	Robotics / Manufacturing Lab - Protein	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	014	Biotech Lab Prep Room #2 (Solution Prep)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-181	Explosion Proof Refrigerator	1	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-186	Autoclave	1	116100	C/C	N	F	28"Lx34"Wx74"H	Getinge	GE-633LS	with Integral steam generator
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-187	Exhaust Canopy	1	Div.23	C/C	N	C				
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-188	Ice Maker	1	116500	C/C	N	F	30"Lx34"Wx72"H	Scotsman	FME504AS-1A	with HTB555-H Storage Bin
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-189	Glassware Washer	1	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-190	Baking Oven	1	NIC	O/O	E	B	24"Lx24"Wx49"H	VWR	1327F	
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-198	Washer	1	NIC	O/O	N	F	29"Lx27"Wx46"H	LG	WT5001CW	
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-199	Dryer	1	NIC	O/O	N	F	29"Lx27"Wx46"H	LG	DL5001W	
	014	Biotech Lab Prep Room #2 (Solution Prep)	TE-201	Plate Pourer	1	NIC	O/O	N	B				
	015	Biotechnology Instrument Room	FH-04	ADA Fume Hood - 6'	1	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	015	Biotechnology Instrument Room	TE-177	Dry Ice Box	1	NIC	O/O	N	F				
	015	Biotechnology Instrument Room	TE-178	Gel Imager	1	NIC	O/O	N	B				
	015	Biotechnology Instrument Room	TE-179	Gel Dryer	1	NIC	O/O	N	B				
	015	Biotechnology Instrument Room	TE-180	Speed Vac	1	NIC	O/O	N	B				
	015	Biotechnology Instrument Room	TE-181	Explosion Proof Refrigerator	1	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
	015	Biotechnology Instrument Room	TE-182	Confocal Microscope	1	NIC	O/O	N	B				
	015	Biotechnology Instrument Room	TE-183	FACS	1	NIC	O/O	N	B				
	015	Biotechnology Instrument Room	TE-184	LC Mass	1	NIC	O/O	N	B				
	015	Biotechnology Instrument Room	TE-185	Microarray Scanner	1	NIC	O/O	N	B				
	015	Biotechnology Instrument Room	TE-202	Q.P.C.R.	1	NIC	O/O	N	B				
SA240F3	019	Cell Culture/ Protein Lab	TE-01	Microscope	6	NIC	O/O	E	B	9"Lx18"Wx19"H	Nikon	TMS-F	Not Located
HT405	019	Cell Culture/ Protein Lab	TE-02	Autoclave	1	NIC	O/O	E	B	23"Lx22"Wx15"H	Tuttnauer Brinkmann	2340M	Not Located
HT405	019	Cell Culture/ Protein Lab	TE-03	Centrifuge	1	NIC	O/O	E	B	32"Lx23"Wx13"H	Sorvall	RT6000B	Not Located
HT405	019	Cell Culture/ Protein Lab	TE-04	Rotator	1	NIC	O/O	E	B	13"Lx14"Wx16"H	Boekel	Ocelot	Not Located
HT405	019	Cell Culture/ Protein Lab	TE-05	Centrifuge	1	NIC	O/O	E	B	16"Lx26"Wx16"H	Beckman	GS15R	Not Located
HT405	019	Cell Culture/ Protein Lab	TE-06	Drawers	3	NIC	O/O	E	F	15"Lx18"Wx50"H			Not Located
HT405	019	Cell Culture/ Protein Lab	TE-07	Drawers on Wheels	3	NIC	O/O	E	F	10"Lx18"Wx26"H			Not Located

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	019	Cell Culture/ Protein Lab	TE-08	Incubator	1	NIC	O/O	E	B	28"Lx27"Wx36"H	Lab-Line	490NS	Not Located
HT410	019	Cell Culture/ Protein Lab	TE-09	Drawers Cart	1	NIC	O/O	E	F	16"Lx17"Wx50"H			Not Located
HT405	019	Cell Culture/ Protein Lab	TE-10	Drawers	1	NIC	O/O	E	F	15"Lx17"Wx42"H			Not Located
SA240F3	019	Cell Culture/ Protein Lab	TE-11	Water Purification System	1	NIC	O/O	E		17"Lx14"Wx19"H	Elga	Ultra Genetic	May not be used!
SA240F3	019	Cell Culture/ Protein Lab	TE-12	Rotator	1	NIC	O/O	E	B	24"Lx11"Wx12"H	Hybaid	Rotator HR-RI	Not Located
SA240F3	019	Cell Culture/ Protein Lab	TE-13	Rotator	5	NIC	O/O	E	B	10"Lx10"Wx5"H	SARSTDT	TPM-2	Not Located
SA240F3	019	Cell Culture/ Protein Lab	TE-15	Titer plate Shaker	1	NIC	O/O	E	B	11"Lx11"Wx8"H	Lab-Line	4625	Not Located
SA240F3	019	Cell Culture/ Protein Lab	TE-16	Stirrer	1	NIC	O/O	E	B	19"Lx16"Wx7"H	Lab-Line	Multi Stirrer Mistral	Not Located
SA240F3	019	Cell Culture/ Protein Lab	TE-17	Vacuum Pressure	14	NIC	O/O	E	B	8"Lx5"Wx9"H	Barnant Company	400-3910	Not Located
SA240F3	019	Cell Culture/ Protein Lab	TE-18	Drawers	7	NIC	O/O	E	F	15"Lx17"Wx51"H			Not Located
SA240F3	019	Cell Culture/ Protein Lab	TE-19	Drawers	8	NIC	O/O	E	F	15"Lx18"Wx26"H			Not Located
SA243	019	Cell Culture/ Protein Lab	TE-20	Plate Reader	2	NIC	O/O	E	B	18"Lx19"Wx10"H	BMG Labs	Fluoster	Not Located
SA243	019	Cell Culture/ Protein Lab	TE-21	Incubator	1	NIC	O/O	E	F	22"Lx22"Wx94"H	Precision		Not Located
SA243	019	Cell Culture/ Protein Lab	TE-22	(-20º) Freezer	1	NIC	O/O	E	F	32"Lx31"Wx71"H	Kenmore		
	019	Cell Culture/ Protein Lab	TE-160	BioSafety Cabinet	1	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	
	019	Cell Culture/ Protein Lab	TE-161	BioSafety Cabinet	4	123450	C/C	N	F	78"Lx33"Wx95"H	NuAire	NU-425-600	
	019	Cell Culture/ Protein Lab	TE-162	CO2 Incubator	8	NIC	O/O	N	F	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
	019	Cell Culture/ Protein Lab	TE-163	Fluorescent Microscope	1	NIC	O/O	N	B				
	019	Cell Culture/ Protein Lab	TE-164	Portable Autoclave	1	NIC	O/O	N	F	20"Lx22"Wx45"H	Tomy	SX-300 / SX-500	
	019	Cell Culture/ Protein Lab	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	019	Cell Culture/ Protein Lab	TE-167	(-80º) Freezer	1	NIC	O/O	N	F	36"Lx35"Wx78"H	NuAire	NU-9483GC	
	019	Cell Culture/ Protein Lab	TE-168	(-150º) Freezer	1	NIC	O/O	N	F	58"Lx29"Wx43"H	Revco	ULT7150-9-D	
	019	Cell Culture/ Protein Lab	TE-169	4ºC Storage Refrigerator	1	NIC	O/O	N	F	36"Lx34"Wx69"H	VWR	13501-926	
	021	Biotech Lab Stock Room	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	021	Biotech Lab Stock Room	TE-191	(-20º) Freezer	1	NIC	O/O	N	F				
	021	Biotech Lab Stock Room	TE-192	(-80º) Freezer	2	NIC	O/O	N	F				
	024	Immunology / DNA Instrument Lab	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
SA240F3	024	Immunology / DNA Instrument Lab	TE-42	Speed Vac	1	NIC	O/O	E	B	12"Lx12"Wx10"H	Savent		Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-43	Agorose Gel Box	1	NIC	O/O	E	B	8"Lx11"Wx4"H	Bio Rad	Sub-Cell GT Wide Mini	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-44	Agorose Gel Box	3	NIC	O/O	E	B	11"Lx5"Wx5"H	Bio Rad	Sub-Cell GT Mini	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-45	Thermocycler	2	NIC	O/O	E	B	13"Lx24"Wx8"H	Perkin Elmer	Gene AMP 2400	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-46	Power Supply	1	NIC	O/O	E	B	9"Lx6"Wx5"H	Fotodyne		Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-47	Power Supply	2	NIC	O/O	E	B	13"Lx13"Wx6"H	Gibco BRL Technologies	4001	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-48	Heat Block	5	NIC	O/O	E	B	8"Lx10"Wx4"H	Thermolyne	Type 17600 Dry Bath	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-49	Vacuum Pressure	1	NIC	O/O	E	B	8"Lx5"Wx9"H	Barnant Company	400-3910	Not Located

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
HT410	024	Immunology / DNA Instrument Lab	TE-50	Gel Dryer	1	NIC	O/O	E	B	22"Lx18"Wx5"H	Bio Rad	583	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-51	Voltage Booster	1	NIC	O/O	E	B	7"Lx12"Wx8"H	BRL		Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-52	Cell Porater	2	NIC	O/O	E	B	10"Lx8"Wx7"H	Gibco BRL Technologies	1613 Series	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-53	Cell Porater	8	NIC	O/O	E	B	6"Lx12"Wx6"H	BRL	1600 Series	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-54	Explosion Proof Refrigerator	1	NIC	O/O	E	F	24"Lx23"Wx71"H	Revco / VWR		To Be Replaced??
HT405	024	Immunology / DNA Instrument Lab	TE-55	Water Bath	1	NIC	O/O	E	B	26"Lx15"Wx14"H	Precision	Dual Chamber 188	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-56	Shaker	1	NIC	O/O	E	B	18"Lx28"Wx19"H	New Brunswick	G24 Environmental Incubator Shaker	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-57	Incubator	1	NIC	O/O	E	B	16"Lx17"Wx17"H	Elconap Lab Apparatus		Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-58	Agorose Gel Box	1	NIC	O/O	E	B	8"Lx11"Wx5"H	Bio Rad	Sub-Cell GT Wide Mini	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-59	Spectrophotometer	7	NIC	O/O	E	B	13"Lx11"Wx6"H	Bio Rad	Smart Spec 3000	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-60	Vortex	2	NIC	O/O	E	B	5"Lx6"Wx7"H	VWR	K-550-G	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-61	Vortex	1	NIC	O/O	E	B	5"Lx7"Wx8"H	Thermolyne	MAXI-MIX11	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-62	Balance	3	NIC	O/O	E	B	9"Lx14"Wx4"H	Denver Inst. Co.	TR 603D	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-63	Balance	3	NIC	O/O	E	B	9"Lx14"Wx4"H	Fox Scientific	XR-603D	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-64	Microcentrifuge	4	NIC	O/O	E	B	8"Lx11"Wx11"H	Eppendorf	5412X1, 5415X1, 5415CX2	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-65	Stirrer Hot Plate	1	NIC	O/O	E	B	8"Lx8"Wx5"H	Thermolyne	SP46925	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-66	Stirrer Hot Plate	1	NIC	O/O	E	B	8"Lx8"Wx4"H	Corning	PC-320	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-67	Agarose Gel Box	9	NIC	O/O	E	B	5"Lx10"Wx5"H	Bio Rad	Sub Cell GT Mini	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-68	Stirrer Hot Plate	2	NIC	O/O	E	B	11"Lx8"Wx4"H	Thermolyne	SP18425	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-69	Stirrer Hot Plate	4	NIC	O/O	E	B	8"Lx6"Wx5"H	Corning	PC-3310	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-70	Vortex	5	NIC	O/O	E	B	5"Lx6"Wx7"H	Fisher	Genie 2 G-560	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-71	BioSafety Cabinet	1	NIC	O/O	E	F	38"Lx26"Wx86"H	Labconco	Purifier Class II	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-72	Heat Block	1	NIC	O/O	E	B	8"Lx10"Wx4"H	Thermolyne	1700 Dry Bath	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-73	Balance	1	NIC	O/O	E	B	9"Lx12"Wx4"H	Sartorius		Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-74	Power Supply	4	NIC	O/O	E	B	9"Lx11"Wx4"H	Bio Rad	Power Pac 200	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-75	UV Transiluminator	1	NIC	O/O	E	B	9"Lx8"Wx7"H	Fotodyne	Foto/phoresis I I-1430	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-76	DI Water Polisher	1	NIC	O/O	E	W	23"Lx14"Wx24"H	Barnstead	NANOpure	To Be Replaced??
HT405	024	Immunology / DNA Instrument Lab	TE-77	Microwave Oven	1	NIC	O/O	E	B	24"Lx18"Wx16"H	Kenmore	99901	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-78	pH Meter	1	NIC	O/O	E	B	10"Lx10"Wx13"H	Accumet	AB15	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-79	Colony Counter	2	NIC	O/O	E	B	11"Lx10"Wx12"H	Leica	3325	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-80	Fluorometer	1	NIC	O/O	E	B	9"Lx11"Wx7"H	Hoeter	DNA Fluorometer TK0100	Not Located

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
SA240F3	024	Immunology / DNA Instrument Lab	TE-81	Platform	1	NIC	O/O	E	B	16"Lx14"Wx7"H	Labline	4361R	Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-82	Spectro Fluorometer	1	NIC	O/O	E	B	15"Lx16"Wx7"H	Tecan Spectra Fluor		Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-83	Spectrophotometer	1	NIC	O/O	E	B	19"Lx23"Wx9"H	Milton Roy	Spectronic Genesys 5	Not Located
SA240	024	Immunology / DNA Instrument Lab	TE-84	(-80º) Freezer	1	NIC	O/O	E	F	72"Lx31"Wx42"H	Revco	ULT 1490	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-85	Homogenizer	1	NIC	O/O	E	B	3"Lx5"Wx18"H	IKA Labor Technik		Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-86	Digital Ionalyzer	2	NIC	O/O	E	B	10"Lx6"Wx6"H	Orion Research	501	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-87	Plate Reader	1	NIC	O/O	E	B	14"Lx16"Wx9"H	Dynex	MRX Revolation	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-88	Cabinet	1	NIC	O/O	E	F	47"Lx16"Wx83"H			Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-89	Light Box	1	NIC	O/O	E	B	13"Lx10"Wx4"H	VWR		Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-90	Page Box	1	NIC	O/O	E	B	7"Lx5"Wx7"H	Bio Rad	Mini-Transblot	Not Located
HT405	024	Immunology / DNA Instrument Lab	TE-91	(-80º) Freezer	1	NIC	O/O	E	F	35"Lx26"Wx21"H	Revco	ULT 185-5-A12	
HT405	024	Immunology / DNA Instrument Lab	TE-92	Hybridization Oven	1	NIC	O/O	E	B	15"Lx10"Wx22"H	Techne	Hybridizer HB-1D	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-93	Cold Box	1	NIC	O/O	E	F	28"Lx35"Wx79"H			Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-94	Fraction Collector	1	NIC	O/O	E	B	10"Lx16"Wx16"H	Spectra/CHROM	CF-1	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-95	Power Supply	1	NIC	O/O	E	B	11"Lx12"Wx5"H	Bio Rad	Power Pac 1000	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-96	Power Supply	1	NIC	O/O	E	B	13"Lx10"Wx6"H	E-C-Apparatus	Series 90	Not Located
	024	Immunology / DNA Instrument Lab	TE-97	Power Supply	2	NIC	O/O	E	B	16"Lx10"Wx8"H	BRL	4000	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-98	Stirrer Hot Plate	1	NIC	O/O	E	B	11"Lx7"Wx4"H	Thermolyne	NUOVA II	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-99	Microfuge	1	NIC	O/O	E	B	9"Lx12"Wx8"H	Hevaeus	Biofuge Pico	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-100	Power Supply	1	NIC	O/O	E	B	7"Lx12"Wx5"H	Bio Rad	1000 / 500	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-101	Power Supply	3	NIC	O/O	E	B	8"Lx12"Wx3"H	Bio Rad	Power Pac 200	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-102	Power Supply	1	NIC	O/O	E	B	11"Lx12"Wx5"H	Bio Rad	Power Pac 3000	Not Located
	024	Immunology / DNA Instrument Lab	TE-103	2-D Gel Box	3	NIC	O/O	E	B	9"Lx6"Wx8"H	Bio Rad	Criterton	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-104	Vortex	1	NIC	O/O	E	B	5"Lx6"Wx7"H	VWR	Vortexer 2 G-560	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-105	Balance	1	NIC	O/O	E	B	9"Lx12"Wx9"H	Mettler Toledo	PB 303-S	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-106	Mixer	1	NIC	O/O	E	B	6"Lx5"Wx7"H	Laboraft	259-490	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-107	Balance	1	NIC	O/O	E	B	8"Lx12"Wx3"H	Mettler Toledo	PB 1502	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-108	Line Cinditioner	1	NIC	O/O	E	B	8"Lx7"Wx6"H	Tripplite	LC 1800	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-109	Stirrer	2	NIC	O/O	E	B	8"Lx8"Wx4"H	Corning	PC-318	Not Located
	024	Immunology / DNA Instrument Lab	TE-110	Transblot	2	NIC	O/O	E	B	15"Lx10"Wx5"H	Bio Rad	SD Semi Dry	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-111	Water Bath	1	NIC	O/O	E	B	8"Lx10"Wx8"H	Precision	181	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-112	Gel Box	1	NIC	O/O	E	B	14"Lx8"Wx14"H	Bio Rad	Protean 11XI Cell	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-113	Microwave Oven	1	NIC	O/O	E	B	21"Lx15"Wx12"H	Kenmore	721.6828	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-114	Water Bath	1	NIC	O/O	E	B	16"Lx20"Wx11"H	Baxter		Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-115	Balance	1	NIC	O/O	E	B	8"Lx8"Wx16"H	Sartorius	Handy	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-116	Heat Block	1	NIC	O/O	E	B		VWR		Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-117	Fraction Collector	1	NIC	O/O	E	B	11"Lx6"Wx13"H	Gilson	Microfractionator	Not Located
	024	Immunology / DNA Instrument Lab	TE-118	Vortex	1	NIC	O/O	E	B	5"Lx11"Wx3"H	VWR IKA	Minivortexer MVI	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-119	Transblot Cell	2	NIC	O/O	E	B	7"Lx5"Wx6"H	Bio Rad	Mini Transblot	Not Located

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
SA240F3	024	Immunology / DNA Instrument Lab	TE-120	Oven	1	NIC	O/O	E	B	11"Lx15"Wx12"H	Organon Teknika	OTC 100	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-121	Fraction Collector	1	NIC	O/O	E	B	14"Lx13"Wx14"H	Advantec	SF-2120	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-122	Stirrer	2	NIC	O/O	E	B		Thermolyne	Type 7200	Not Located
SA245	024	Immunology / DNA Instrument Lab	TE-123	Vortex	1	NIC	O/O	E	B	5"Lx7"Wx7"H	Fisher	Genie 2 G-560	Not Located
SA245	024	Immunology / DNA Instrument Lab	TE-124	Stirrer	1	NIC	O/O	E	B	9"Lx10"Wx5"H	Fisher		Not Located
SA245	024	Immunology / DNA Instrument Lab	TE-125	Heat Block	1	NIC	O/O	E	B	8"Lx12"Wx4"H	VWR	Heat Block II	Not Located
SA245	024	Immunology / DNA Instrument Lab	TE-126	Heat Block	1	NIC	O/O	E	B	8"Lx6"Wx4"H	Curtin Matheson		Not Located
SA245	024	Immunology / DNA Instrument Lab	TE-127	Stirrer	1	NIC	O/O	E	B	7"Lx11"Wx4"H	VWR	300	Not Located
SA245	024	Immunology / DNA Instrument Lab	TE-128	Stirrer	3	NIC	O/O	E	B	12"Lx8"Wx4"H	Thermolyne	NUOVA II	Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-129	Shaking Water Bath	1	NIC	O/O	E	B	23"Lx13"Wx11"H	GCA Corp.		Not Located
SA245	024	Immunology / DNA Instrument Lab	TE-130	Water Bath	2	NIC	O/O	E	B	16"Lx23"Wx24"H	New Brunswick	G76	Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-131	Spectrophotometer	1	NIC	O/O	E	B	6"Lx20"Wx12"H	Waters	481	Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-132	Vacuum Oven	1	NIC	O/O	E	B	14"Lx17"Wx21"H	Lab Line	N 7595-1	Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-133	Shelves	4	NIC	O/O	E	F	48"Lx19"Wx84"H			Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-134	Shelves	1	NIC	O/O	E	F	24"Lx11"Wx84"H			Not Located
HT410	024	Immunology / DNA Instrument Lab	TE-135	Shelves	2	NIC	O/O	E	F	30"Lx12"Wx59"H			Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-136	Shelves	4	NIC	O/O	E	F	35"Lx18"Wx74"H			Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-137	Shelves	2	NIC	O/O	E	F	28"Lx18"Wx68"H			Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-138	Cart	2	NIC	O/O	E	F	25"Lx40"Wx33"H			Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-139	Gear Pump Drive	2	NIC	O/O	E	B	7"Lx13"Wx6"H			Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-140	HPLC	1	NIC	O/O	E	B	15"Lx17"Wx14"H	Waters	WISP 710B	Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-141	Solvent Delivery System	2	NIC	O/O	E	B	11"Lx11"Wx9"H	Waters	510	Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-142	Gradient Controller	1	NIC	O/O	E	B	12"Lx21"Wx8"H	Waters		Not Located
SA243	024	Immunology / DNA Instrument Lab	TE-143	Data Module (FPLC)	1	NIC	O/O	E	B	20"Lx19"Wx7"H	Waters	730	Not Located
SA240	024	Immunology / DNA Instrument Lab	TE-144	Automated Workstation - Part 2	1	NIC	O/O	E	B	20"Lx18"Wx9"H	Beckman	Biomek 1000	Not Located
SA240	024	Immunology / DNA Instrument Lab	TE-145	Automated Workstation - Part 1	1	NIC	O/O	E	B	29"Lx16"Wx25"H	Beckman	Biomek 1000	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-146	Microcentrifuge	1	NIC	O/O	E	B	10"Lx10"Wx9"H	Fisher Scientific	235A	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-147	Hot Plate Stirrer	1	NIC	O/O	E	B	8"Lx6"Wx5"H	Corning	PC-351	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-148	Water Bath	1	NIC	O/O	E	B	9"Lx10"Wx13"H	Lab-Line	273-807	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-149	BioSafety Cabinet	1	NIC	O/O	E	F	74"Lx29"Wx86"H	Labconco	36213	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-150	BioSafety Cabinet	1	NIC	O/O	E	F	78"Lx32"Wx90"H	Thermo Forma	1286	Not Located
	024	Immunology / DNA Instrument Lab	TE-151	Incubator	1	NIC	O/O	N	F	25"Lx24"Wx82"H	Forma	3326	Not Located
	024	Immunology / DNA Instrument Lab	TE-152	Stirring Hot Plate	1	NIC	O/O	N	B	8"Lx10"Wx6"H	Allied-Fisher Scientific	310T	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-153	Heat Block	1	NIC	O/O	E	B	8"Lx6"Wx4"H	VWR		Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-154	pH Meter	1	NIC	O/O	E	B	8"Lx6"Wx4"H	Accumet	AB15	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-155	Incubator	1	NIC	O/O	E	B	25"Lx25"Wx39"H	VWR	2200	Not Located
SA240F3	024	Immunology / DNA Instrument Lab	TE-156	Incubator	1	NIC	O/O	E	B	32"Lx32"Wx43"H	Forma	3860	Not Located
	024	Immunology / DNA Instrument Lab	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	024	Immunology / DNA Instrument Lab	TE-169	(4º C) Storage Refrigerator	1	NIC	O/O	N	F	36"Lx34"Wx69"H	VWR	13501-926	

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	024	Immunology / DNA Instrument Lab	TE-171	(-20º) Freezer	1	NIC	O/O	N	F	30"Lx34"Wx78"H	VWR-Thermo	ULT1340-9-A	
	024	Immunology / DNA Instrument Lab	TE-172	Refrigerated Centrifuge	1	NIC	O/O	N	F				
	024	Immunology / DNA Instrument Lab	TE-197	Incubator / Shaker	2	NIC	O/O	N	F	42"Lx34"Wx46"H	ATR (Infors HT)	Minitron or Multitron II	Double Stacked
	025	Recitation Room	TE-196	Laser Printer	2	NIC	O/O	N	B				
	026	Student Project Biotech Lab	TE-160	BioSafety Cabinet	1	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	
	026	Student Project Biotech Lab	TE-162	CO2 Incubator	2	NIC	O/O	N	F	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
	026	Student Project Biotech Lab	TE-165	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	026	Student Project Biotech Lab	TE-194	Refrigerator / Freezer	1	NIC	O/O	N	F	24"Lx25"Wx35"H	VWR	82028-016	Undercounter

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	080	Chemical Waste Storage											
SA240	213	General Chemistry Lab #1	CE-01	Hot Plate	6	NIC	O/O	E	B	7"Lx7"Wx5"H	Corning	PC200	Not Located
SA240	213	General Chemistry Lab #1	CE-02	Hot Plate	4	NIC	O/O	E	B	8"Lx12"Wx4"H	Fisher		Not Located
	213	General Chemistry Lab #1	CE-04	Hot Plate	2	NIC	O/O	N	B	7"Lx7"Wx6"H	VWR	986972	Not Located
	213	General Chemistry Lab #1	CE-05	Analytical Balance	4	NIC	O/O	N	B		Mettler Toledo	XP504	
SA240	213	General Chemistry Lab #1	CE-06	Analytical Balance	4	NIC	O/O	E	B	8"Lx17"Wx13"H	Fisher / Denver	EMD-310	Defective. Replace w/ CE-05
SA240	213	General Chemistry Lab #1	CE-07	Water Bath	1	NIC	O/O	E	B	14"Lx20"Wx14"H	VWR	1203	Not Located
SA239	213	General Chemistry Lab #1	CE-10	Centrifuge	3	NIC	O/O	E	B		VWR	Clinical 100	Not Located
SA239	213	General Chemistry Lab #1	CE-12	pH Meter	2	NIC	O/O	E	B	12"Lx12"Wx12"H	Corning	430	Not Located
SA239	213	General Chemistry Lab #1	CE-13	pH Meter	6	NIC	O/O	E	B	12"Lx12"Wx12"H	Corning	M530P/530	Not Located
SA239	213	General Chemistry Lab #1	CE-14	pH Meter	7	NIC	O/O	E	B	12"Lx12"Wx12"H	Corning	215	Fair / Poor Condition
SA239	213	General Chemistry Lab #1	CE-15	Stir Plate	13	NIC	O/O	E	B		Fisher	11-510-165-B	Not Located
SA240	213	General Chemistry Lab #1	CE-16	Vortex Mixer	1	NIC	O/O	E	B	5"Lx7"Wx7"H	Fisher	G-560	Not Located
	213	General Chemistry Lab #1	CE-17	Vortex Mixer	6	NIC	O/O	N	B	5"Lx7"Wx7"H	Fisher	G-560	Not Located
SA239	213	General Chemistry Lab #1	CE-18	Spectronic 20/20+	3	NIC	O/O	E	B	16"Lx13"Wx9"H	Thermo	Spectronic 20/20+	7 Fair, 3 Defective.
SA239	213	General Chemistry Lab #1	CE-20	Geiger Counter	3	NIC	O/O	E	B	12"Lx8"Wx4"H	Daedalon Corp.	EN-15	Not Located
	213	General Chemistry Lab #1	CE-27	Laser Printer	1	NIC	O/O	N	B				
	213	General Chemistry Lab #1	CE-28	Rolled-Up Periodic Table	1	NIC	O/O	N	C	58"Lx42"H	Fisher Scientific	S45525A	With spring roller
	213	General Chemistry Lab #1	FH-03	Fume Hood - 6'	5	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	213	General Chemistry Lab #1	FH-04	ADA Fume Hood - 6'	1	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
SA239	215	Chemistry Lab Prep Room #1 (General)	CE-21	Magnetizer	1	NIC	O/O	E	B	12"Lx4"Wx6"H	Electro-Technic Products Inc.	28000	Not Located
SA239	215	Chemistry Lab Prep Room #1 (General)	CE-22	Analytical Balance	1	NIC	O/O	E	B	8"Lx14"Wx14"H	Mettler Toledo	PG 503	Not Located
SA239	215	Chemistry Lab Prep Room #1 (General)	CE-23	Induction Coil	1	NIC	O/O	E	B	18"Lx14"Wx10"H	Seargent Welch	S68755	Not Located
	215	Chemistry Lab Prep Room #1 (General)	CE-24	Power Supply	2	NIC	O/O	N	B	8"Lx7"Wx5"H	Central Scientific	33031	Not Located
	215	Chemistry Lab Prep Room #1 (General)	CE-25	Ice Maker	1	116500	C/C	N	F	30"Lx34"Wx72"H	Scotsman	FME504AS-1A	with HTB555-H Storage Bin
	215	Chemistry Lab Prep Room #1 (General)	CE-26	Glassware Washer	1	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
	215	Chemistry Lab Prep Room #1 (General)	CE-61	Hot Plate / Stirrer	1	NIC	O/O	N	B	8"Lx8"Wx5"H	Cimarec / Barnstead	SP46925	Not Located
	215	Chemistry Lab Prep Room #1 (General)	CE-66	Oven	1	NIC	O/O	N	B	24"Lx22"Wx28"H	VWR	52352-094	
	215	Chemistry Lab Prep Room #1 (General)	FH-01	Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	215	Chemistry Lab Prep Room #1 (General)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	215A	Chemistry Lab Stock Room #1 (General)	CE-74	Explosion Proof Refrigerator	2	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
	215A	Chemistry Lab Stock Room #1 (General)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
SA240	217	General Chemistry Lab #2	CE-03	Hot Plate	12	NIC	O/O	E	B	7"Lx7"Wx6"H	VWR	986972	Not Located
	217	General Chemistry Lab #2	CE-05	Analytical Balance	4	NIC	O/O	N	B		Mettler Toledo	XP504	
SA240	217	General Chemistry Lab #2	CE-07	Water Bath	1	NIC	O/O	E	B	14"Lx20"Wx14"H	VWR	1203	Not Located
SA239	217	General Chemistry Lab #2	CE-10	Centrifuge	3	NIC	O/O	E	B		VWR	Clinical 100	Not Located
SA239	217	General Chemistry Lab #2	CE-18	Spectronic 20/20+	3	NIC	O/O	E	B	16"Lx13"Wx9"H	Thermo	Spectronic 20/20+	7 Fair, 3 Defective.
SA239	217	General Chemistry Lab #2	CE-20	Geiger Counter	3	NIC	O/O	E	B	12"Lx8"Wx4"H	Daedalon Corp.	EN-15	Not Located
	217	General Chemistry Lab #2	CE-27	Laser Printer	1	NIC	O/O	N	B				
	217	General Chemistry Lab #2	CE-28	Rolled-Up Periodic Table	1	NIC	O/O	N	C	58"Lx42"H	Fisher Scientific	S45525A	With spring roller
	217	General Chemistry Lab #2	FH-03	Fume Hood - 6'	5	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	217	General Chemistry Lab #2	FH-04	ADA Fume Hood - 6'	1	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	218	Chemical Stock Room #1	FH-01	Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	218A	Chemical Stock Room #2											
	220	Chemistry Lab Prep Room #2 (Organic)	CE-25	Ice Maker	1	116500	C/C	N	F	30"Lx34"Wx72"H	Scotsman	FME504AS-1A	with HTB555-H Storage Bin
	220	Chemistry Lab Prep Room #2 (Organic)	CE-26	Glassware Washer	1	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
SA240	220	Chemistry Lab Prep Room #2 (Organic)	CE-38	Hood	1	NIC	O/O	E	B	13"Lx29"Wx54"H	Labconco	69100-00	Not Located
	220	Chemistry Lab Prep Room #2 (Organic)	CE-60	Hot Plate / Stirrer	1	NIC	O/O	E	B	8"Lx8"Wx5"H	Cimarec / Barnstead	SP46925	Not Located
	220	Chemistry Lab Prep Room #2 (Organic)	CE-64	Balance	1	NIC	O/O	E	B	7"Lx13"Wx7"H	Ohaus	GT410	Poor. Replace w/ CE-65
	220	Chemistry Lab Prep Room #2 (Organic)	CE-65	Balance	1	NIC	O/O	N	B		Mettler Toledo	XP204	Not Located
	220	Chemistry Lab Prep Room #2 (Organic)	CE-66	Oven	1	NIC	O/O	N	B	24"Lx22"Wx28"H	VWR	52352-094	
	220	Chemistry Lab Prep Room #2 (Organic)	FH-01	Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	220	Chemistry Lab Prep Room #2 (Organic)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
SA239	220A	Chemistry Lab Stock Room #2 (Organic)	CE-59	Refrigerator	1	NIC	O/O	E	F	30"Lx35"Wx60"H	Lab-Line	3551/3559	
	220A	Chemistry Lab Stock Room #2 (Organic)	CE-74	Explosion Proof Refrigerator	1	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
	220A	Chemistry Lab Stock Room #2 (Organic)	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	221	General Chemistry Lab Recitation #1	CE-27	Laser Printer	1	NIC	O/O	N	B				
	221	General Chemistry Lab Recitation #1	CE-28	Rolled-Up Periodic Table	1	NIC	O/O	N	C	58"Lx42"H	Fisher Scientific	S45525A	With spring roller
SA239	222	Organic Chemistry Lab #1	CE-32	UV Light Box	1	NIC	O/O	E	B	10"Lx9"Wx10"H	UVP Inc.	UVG-54	Not Located
SA239	222	Organic Chemistry Lab #1	CE-33	Water Bath	2	NIC	O/O	E	B	15"Lx17"Wx15"H	Fisher Isotemp	210	Not Located
SA239	222	Organic Chemistry Lab #1	CE-35	Stir Plate	8	NIC	O/O	E	B	5"Lx5"Wx2"H	Hanna	HI200	Not Located
SA239	222	Organic Chemistry Lab #1	CE-36	Heating Mantle	18	NIC	O/O	E	B	9"Lx5"Wx2"H	Glas-Col	Series 0	Not Located
SA239	222	Organic Chemistry Lab #1	CE-39	Balance	2	NIC	O/O	E	B	9"Lx12"Wx4"H	Ohaus	AV212C	
	222	Organic Chemistry Lab #1	CE-40	Balance	2	NIC	O/O	N	B	9"Lx12"Wx4"H	Ohaus	AV212C	
SA240	222	Organic Chemistry Lab #1	CE-41	Balance	1	NIC	O/O	E	B	8"Lx14"Wx8"H	Scientech	SP250	
SA239	222	Organic Chemistry Lab #1	CE-42	Analytical Balance	1	NIC	O/O	E	B	15"Lx10"Wx14"H	Ainsworth	PI314A	
SA240	222	Organic Chemistry Lab #1	CE-44	Explosion Proof Hot Plate	1	NIC	O/O	E	B	8"Lx7"Wx4"H		HP 11500B	Hard wired inside fume hood
SA239	222	Organic Chemistry Lab #1	CE-48	Mini Hot Plates	16	NIC	O/O	E	B	5"Lx7"Wx6"H	VWR	986972	Not Located
SA240	222	Organic Chemistry Lab #1	CE-54	Variac	16	NIC	O/O	E		6"Lx8"Wx6"H	Staco	3PN 10101B	
SA240	222	Organic Chemistry Lab #1	CE-56	Sand Bath	21	NIC	O/O	E	B	5"Lx5"Wx3"H	Laboratory Craftsman	100ML C3AM	Not Located
	222	Organic Chemistry Lab #1	FH-01	Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	222	Organic Chemistry Lab #1	FH-03	Fume Hood - 6'	7	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	222	Organic Chemistry Lab #1	FH-04	ADA Fume Hood - 6'	1	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
SA240	224	General Chemistry Lab #3	CE-03	Hot Plate	1	NIC	O/O	E	B	7"Lx7"Wx6"H	VWR	986972	Not Located
	224	General Chemistry Lab #3	CE-04	Hot Plate	11	NIC	O/O	N	B	7"Lx7"Wx6"H	VWR	986972	Not Located
	224	General Chemistry Lab #3	CE-05	Analytical Balance	4	NIC	O/O	N	B		Mettler Toledo	XP504	
	224	General Chemistry Lab #3	CE-08	Water Bath	1	NIC	O/O	N	B	14"Lx20"Wx14"H	VWR	1203	Not Located
SA240	224	General Chemistry Lab #3	CE-09	Water Bath	1	NIC	O/O	E	B	15"Lx18"Wx14"H	Precision	184	Defective. Replace w/ CE-08
SA239	224	General Chemistry Lab #3	CE-10	Centrifuge	2	NIC	O/O	E	B		VWR	Clinical 100	Not Located
	224	General Chemistry Lab #3	CE-11	Centrifuge	1	NIC	O/O	N	B		VWR	Clinical 100	Not Located
SA239	224	General Chemistry Lab #3	CE-18	Spectronic 20/20+	1	NIC	O/O	E	B	16"Lx13"Wx9"H	Thermo	Spectronic 20/20+	7 Fair, 3 Defective.
	224	General Chemistry Lab #3	CE-19	Spectronic 20/20+	2	NIC	O/O	N	B	16"Lx13"Wx9"H	Thermo	Spectronic 20/20+	Not Located
SA239	224	General Chemistry Lab #3	CE-20	Geiger Counter	3	NIC	O/O	E	B	12"Lx8"Wx4"H	Daedalon Corp.	EN-15	Not Located
	224	General Chemistry Lab #3	CE-27	Laser Printer	1	NIC	O/O	N	B				

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	224	General Chemistry Lab #3	CE-28	Rolled-Up Periodic Table	1	NIC	O/O	N	C	58"Lx42"H	Fisher Scientific	S45525A	With spring roller
	224	General Chemistry Lab #3	FH-03	Fume Hood - 6'	5	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	224	General Chemistry Lab #3	FH-04	ADA Fume Hood - 6'	1	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
SA239	225	Organic Chemistry Instrumentation Lab	CE-29	NMR	1	NIC	O/O	E	F	79"Lx79"W	Jeol	JNM-MY60	Will be replaced w/ CE-70
SA239	225	Organic Chemistry Instrumentation Lab	CE-30	GC Plotter	2	NIC	O/O	E	B	14"Lx15"Wx6"H	Gow-Mac	70-150	Not Located
SA239	225	Organic Chemistry Instrumentation Lab	CE-31	GC	3	NIC	O/O	E	B	12"Lx18"Wx17"H	Gow-Mac	Series 350	
SA240	225	Organic Chemistry Instrumentation Lab	CE-45	Melting Point	3	NIC	O/O	E	B	5"Lx6"Wx13"H	Barnstead	1401	Not Located
SA240	225	Organic Chemistry Instrumentation Lab	CE-46	Melting Point	1	NIC	O/O	E	B	7"Lx13"Wx10"H	Stanford	OPTIMELT	Not Located
	225	Organic Chemistry Instrumentation Lab	CE-47	Melting Point	1	NIC	O/O	N	B	7"Lx13"Wx10"H	Stanford	OPTIMELT	Not Located
SA240	225	Organic Chemistry Instrumentation Lab	CE-50	Refractometer	3	NIC	O/O	E	B	6"Lx13"Wx14"H	Thermo	334610	Not Located
	225	Organic Chemistry Instrumentation Lab	CE-51	Refractometer	1	NIC	O/O	N	B	9"Lx12"Wx3"H	Reichert		Not Located
SA239	225	Organic Chemistry Instrumentation Lab	CE-52	Polarimeter	3	NIC	O/O	E	B	15"Lx6"Wx13"H	Linos, Polyscience	SR6	1 poor, Replace w/ CE-53
	225	Organic Chemistry Instrumentation Lab	CE-53	Polarimeter	2	NIC	O/O	N	B	25"Lx13"Wx18"H	Rudolph Autopol II		Not Located
	225	Organic Chemistry Instrumentation Lab	CE-67	FT-IR	2	NIC	O/O	N	B	21"Lx24"Wx12"H	Perkin Elmer	Spectrum 100	Plus PC & Printer for each
	225	Organic Chemistry Instrumentation Lab	CE-68	Snorkel	7	123450	C/C	N	C		Nederman	FX75	Extractor arms w/ hood
	225	Organic Chemistry Instrumentation Lab	CE-69	Cylinder Support	1	123400	C/C	N	W		Lab Safety Supply	9417	Bench Mounted
	225	Organic Chemistry Instrumentation Lab	CE-70	NMR 90 MHz Magnet	1	NIC	O/O	N	F	41"Lx34"Wx34"H	Anasazi	EFT-90	Vibration Sensitive
	225	Organic Chemistry Instrumentation Lab	CE-71	NMR 90 MHz Electronic Cabinet	1	NIC	O/O	N	F	9"Lx25"Wx26"H	Anasazi	EFT-90	Vibration Sensitive
	225	Organic Chemistry Instrumentation Lab	CE-72	NMR 90 MHz Workstation	1	NIC	O/O	N	F	36"Lx30"Wx29"H	Anasazi	EFT-90	Vibration Sensitive
	225	Organic Chemistry Instrumentation Lab	CE-74	Explosion Proof Refrigerator	1	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
	225	Organic Chemistry Instrumentation Lab	FH-04	ADA Fume Hood - 6'	1	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	226	General Chemistry Lab Recitation #2	CE-27	Laser Printer	1	NIC	O/O	N	B				
	226	General Chemistry Lab Recitation #2	CE-28	Rolled-Up Periodic Table	1	NIC	O/O	N	C	58"Lx42"H	Fisher Scientific	S45525A	With spring roller
	228	General Chemistry Lab #4	CE-04	Hot Plate	12	NIC	O/O	N	B	7"Lx7"Wx6"H	VWR	986972	Not Located
	228	General Chemistry Lab #4	CE-05	Analytical Balance	4	NIC	O/O	N	B		Mettler Toledo	XP504	
	228	General Chemistry Lab #4	CE-08	Water Bath	1	NIC	O/O	N	B	14"Lx20"Wx14"H	VWR	1203	Not Located
	228	General Chemistry Lab #4	CE-11	Centrifuge	3	NIC	O/O	N	B		VWR	Clinical 100	Not Located
	228	General Chemistry Lab #4	CE-19	Spectronic 20/20+	3	NIC	O/O	N	B	16"Lx13"Wx9"H	Thermo	Spectronic 20/20+	Not Located
SA239	228	General Chemistry Lab #4	CE-20	Geiger Counter	3	NIC	O/O	E	B	12"Lx8"Wx4"H	Daedalon Corp.	EN-15	Not Located
	228	General Chemistry Lab #4	CE-27	Laser Printer	1	NIC	O/O	N	B				
	228	General Chemistry Lab #4	CE-28	Rolled-Up Periodic Table	1	NIC	O/O	N	C	58"Lx42"H	Fisher Scientific	S45525A	With spring roller
	228	General Chemistry Lab #4	FH-03	Fume Hood - 6'	5	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	228	General Chemistry Lab #4	FH-04	ADA Fume Hood - 6'	1	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
SA239	229	Organic Chemistry Lab #2	CE-32	UV Light Box	1	NIC	O/O	E	B	10"Lx9"Wx10"H	UVP Inc.	UVG-54	Not Located
	229	Organic Chemistry Lab #2	CE-34	Water Bath	2	NIC	O/O	N	B	15"Lx17"Wx15"H	Fisher Isotemp	210	Not Located
SA239	229	Organic Chemistry Lab #2	CE-35	Stir Plate	8	NIC	O/O	E	B	5"Lx5"Wx2"H	Hanna	HI200	Not Located
SA239	229	Organic Chemistry Lab #2	CE-36	Heating Mantle	2	NIC	O/O	E	B	9"Lx5"Wx2"H	Glas-Col	Series 0	Not Located
	229	Organic Chemistry Lab #2	CE-37	Heating Mantle	16	NIC	O/O	N	B	9"Lx5"Wx2"H	Glas-Col	Series 0	Not Located
	229	Organic Chemistry Lab #2	CE-40	Balance	4	NIC	O/O	N	B	9"Lx12"Wx4"H	Ohaus	AV212C	
SA240	229	Organic Chemistry Lab #2	CE-41	Balance	1	NIC	O/O	E	B	8"Lx14"Wx8"H	Scientech	SP250	
	229	Organic Chemistry Lab #2	CE-43	Analytical Balance	1	NIC	O/O	N	B	15"Lx10"Wx14"H	Ainsworth	PI314A	
SA240	229	Organic Chemistry Lab #2	CE-44	Explosion Proof Hot Plate	1	NIC	O/O	E	B	8"Lx7"Wx4"H		HP 11500B	Hard wired inside fume hood
	229	Organic Chemistry Lab #2	CE-49	Mini Hot Plates	16	NIC	O/O	N	B	5"Lx7"Wx6"H	VWR	986972	Not Located
SA240	229	Organic Chemistry Lab #2	CE-54	Variac	2	NIC	O/O	E		6"Lx8"Wx6"H	Staco	3PN 10101B	

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	229	Organic Chemistry Lab #2	CE-55	Variac	14	NIC	O/O	N		6"Lx8"Wx6"H	Staco	3PN 10101B	
	229	Organic Chemistry Lab #2	CE-57	Sand Bath	16	NIC	O/O	N	B	5"Lx5"Wx3"H	Laboratory Craftsman	100ML C3AM	Not Located
	229	Organic Chemistry Lab #2	FH-01	Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	229	Organic Chemistry Lab #2	FH-03	Fume Hood - 6'	7	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	229	Organic Chemistry Lab #2	FH-04	ADA Fume Hood - 6'	1	123450	C/C	N	F	72"Lx36"Wx84"H	Kewaunee		
	233	Organic Chemistry Lab Recitation	CE-27	Laser Printer	2	NIC	O/O	N	B				

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	016	Upper Level Biosciences Lab #1	FH-05	Walk-In Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	016	Upper Level Biosciences Lab #1	UE-01	Balance	2	NIC	O/O	N	B	11"Lx20"Wx13"H	Mettler	XP26	Not Located
	016	Upper Level Biosciences Lab #1	UE-02	Balance	10	NIC	O/O	N	B	10"Lx13"Wx10"H	Mettler	PB403-s-FACT	Not Located
	016	Upper Level Biosciences Lab #1	UE-03	Refrigerated Centrifuge	5	NIC	O/O	N	B	26"Lx27"Wx16"H	Beckman Coulter	Alegra 25R	Not Located
	016	Upper Level Biosciences Lab #1	UE-04	Centrifuge	2	NIC	O/O	N	B	16"Lx34"Wx34"H	Beckman Coulter	Avanti J26XP	Not Located
	016	Upper Level Biosciences Lab #1	UE-05	Micro Centrifuge	5	NIC	O/O	N	B	15"Lx23"Wx12"H	Beckman Coulter	22R wF241.5P	Not Located
	016	Upper Level Biosciences Lab #1	UE-06	Elisa Reader	5	NIC	O/O	N	B	14"Lx13"Wx6"H	Bio Rad	168-1001 Model 680	Not Located
	016	Upper Level Biosciences Lab #1	UE-07	Flow Cytometer	1	NIC	O/O	N	B	24"Lx36"Wx25"H	BD Bioscience	BD FACSCanto	Not Located
	016	Upper Level Biosciences Lab #1	UE-08	HPLC	1	NIC	O/O	N	B	36"Lx24"Wx24"H	Waters	Breeze	Not Located
	016	Upper Level Biosciences Lab #1	UE-09	BioSafety Cabinet	4	123450	C/C	N	F	78"Lx33"Wx95"H	NuAire	NU-425-600	
	016	Upper Level Biosciences Lab #1	UE-10	Imager Analyzer	1	NIC	O/O	N	B	23"Lx28"Wx12"H	Bio Rad	170-9450	Not Located
	016	Upper Level Biosciences Lab #1	UE-11	Incubator	4	NIC	O/O	N	B	12"Lx12"Wx36"H	Fisher	11-690-637F	Not Located
	016	Upper Level Biosciences Lab #1	UE-12	CO2 Incubator	2	NIC	O/O	N	B	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
	016	Upper Level Biosciences Lab #1	UE-13	Shaking Incubator	2	NIC	O/O	N	F	46"Lx32"Wx41"H	New Brunswick	Inova 43	Not Located
	016	Upper Level Biosciences Lab #1	UE-14	Water Bath	4	NIC	O/O	N	B	16"Lx15"Wx9"H	Fisher	15-462-10Q	Not Located
	016	Upper Level Biosciences Lab #1	UE-15	Thermal Cycler	5	NIC	O/O	N	B	10"Lx20"Wx10"H	Bio Rad	170-9780	Not Located
	016	Upper Level Biosciences Lab #1	UE-16	RealTime PCR	5	NIC	O/O	N	B	12"Lx24"Wx16"H	Bio Rad	170-9780 iQ5	Not Located
	016	Upper Level Biosciences Lab #1	UE-17	pH Meter	5	NIC	O/O	N	B	5"Lx6"Wx10"H	Mettler	SevenMulti S40	Not Located
	016	Upper Level Biosciences Lab #1	UE-18	Power Supply	25	NIC	O/O	N	B	7"Lx15"Wx5"H	Bio Rad	164-5070	Not Located
	016	Upper Level Biosciences Lab #1	UE-20	Refrigerator	4	NIC	O/O	N	F	32"Lx52"Wx78"H	Fisher Scientific	13-198-128	Not Located
	016	Upper Level Biosciences Lab #1	UE-21	Confocal Microscope	1	NIC	O/O	N	B	84"Lx120"Wx24"H	Olympus	FV1000-MPE	Vibration Sensitive
	016	Upper Level Biosciences Lab #1	UE-22	Disecting Microscope	10	NIC	O/O	N	B	11"Lx14"Wx23"H	Olympus	SZX12	Not Located
	016	Upper Level Biosciences Lab #1	UE-22	Disecting Microscope	10	NIC	O/O	N	B	11"Lx14"Wx23"H	Olympus	SZX12	Not Located
	016	Upper Level Biosciences Lab #1	UE-23	Microscope	15	NIC	O/O	N	B	10"Lx15"Wx20"H	Olympus	SX31	Not Located
	016	Upper Level Biosciences Lab #1	UE-23	Microscope	15	NIC	O/O	N	B	10"Lx15"Wx20"H	Olympus	SX31	Not Located
	016	Upper Level Biosciences Lab #1	UE-24	Mass Spec	1	NIC	O/O	N	B	48"Lx24"Wx24"H	Brucker Daltonics	Ultra flex III	Not Located
	016	Upper Level Biosciences Lab #1	UE-25	UV Vis Spectrophotometer	10	NIC	O/O	N	B	15"Lx7"Wx5"H	Bio Rad	170-2525	Not Located
	016	Upper Level Biosciences Lab #1	UE-26	DI Water Polisher	2	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	016	Upper Level Biosciences Lab #1	UE-30	Snorkel	3	123450	C/C	N	C		Nederman	FX75	Extractor arms w/ hood
	016	Upper Level Biosciences Lab #1	UE-36	Cylinder Support	1	123400	C/C	N	W		Lab Safety Supply	8446	
	018	Upper Level Biosciences Lab Prep	FH-02	ADA Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	018	Upper Level Biosciences Lab Prep	UE-12	CO2 Incubator	2	NIC	O/O	N	B	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
	018	Upper Level Biosciences Lab Prep	UE-26	DI Water Polisher	1	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	018	Upper Level Biosciences Lab Prep	UE-27	BioSafety Cabinet	1	123450	C/C	N	F	54"Lx33"Wx95"H	NuAire	NU-425-400	
	018	Upper Level Biosciences Lab Prep	UE-28	Glassware Washer	1	116100	C/C	N	F	24"Lx24"Wx34"H	Miele	G 7883	Undercounter
	018	Upper Level Biosciences Lab Prep	UE-30	Snorkel	1	123450	C/C	N	C		Nederman	FX75	Extractor arms w/ hood
	018A	Upper Level Biosciences Equipment Room	UE-19	(-80º) Freezer	1	NIC	O/O	N	F	36"Lx35"Wx78"H	NuAire	NU-9483GC	
	018A	Upper Level Biosciences Equipment Room	UE-31	Explosion Proof Refrigerator	1	116500	C/C	N	F	21"Lx18"Wx62"H	VWR	55703-442	
	018A	Upper Level Biosciences Equipment Room	UE-32	(-20º) Freezer	1	NIC	O/O	N	F	30"Lx34"Wx78"H	VWR-Thermo	ULT1340-9-A	
	018A	Upper Level Biosciences Equipment Room	UE-33	Centrifuge	2	NIC	O/O	N	B				
	018A	Upper Level Biosciences Equipment Room	UE-34	Centrifuge	1	NIC	O/O	N	F				

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
	020	Upper Level Biosciences Lab #2	FH-05	Walk-In Fume Hood - 4'	1	123450	C/C	N	F	48"Lx36"Wx84"H	Kewaunee		
	020	Upper Level Biosciences Lab #2	UE-09	BioSafety Cabinet	4	123450	C/C	N	F	78"Lx33"Wx95"H	NuAire	NU-425-600	
	020	Upper Level Biosciences Lab #2	UE-12	CO2 Incubator	2	NIC	O/O	N	B	25"Lx27"Wx41"H	NuAire	NU 8500	Double Stacked
	020	Upper Level Biosciences Lab #2	UE-26	DI Water Polisher	2	116500	C/C	N	WL	13"Lx15"Wx20"H	Millipore	Milli-Q Advantage A10	with Q-POD
	020	Upper Level Biosciences Lab #2	UE-30	Snorkel	3	123450	C/C	N	C		Nederman	FX75	Extractor arms w/ hood
	020	Upper Level Biosciences Lab #2	UE-36	Cylinder Support	1	123400	C/C	N	W		Lab Safety Supply	8446	
	214	Upper Level Biosciences Lab Recitation	UE-35	Laser Printer	2	NIC	O/O	N	B				Not Located

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

Existing Room Number	Room Number	Space Name	Equip No.	Description	Quantity	Spec. No.	Furnish / Install	New / Exist	Mounted	Size	Manuf.	Model No.	Remarks
SA202		Science Learning Center	LE-01a	Computer (Base)	22	NIC	O/O	E	B	5"Lx22"Wx20"H			Not Located
SA202		Science Learning Center	LE-01b	Monitor & Mouse	22	NIC	O/O	E	B	27"Lx15"Wx16"H			Not Located
		Science Learning Center	LE-02a	Computer (Base)	45	NIC	O/O	N	B	5"Lx22"Wx20"H			Not Located
		Science Learning Center	LE-02b	Monitor & Mouse	45	NIC	O/O	N	B	27"Lx15"Wx16"H			Not Located
SA202		Science Learning Center	LE-03	TV with VCR	2	NIC	O/O	E	B	20"Lx10"Wx20"H			Not Located
		Science Learning Center	LE-04	TV with VCR	2	NIC	O/O	N	B	20"Lx10"Wx20"H			Not Located
SA202		Science Learning Center	LE-05	Printer	2	NIC	O/O	E	B	22"Lx26"Wx25"H			Not Located
		Science Learning Center	LE-06	Printer	3	NIC	O/O	N	B	22"Lx26"Wx25"H			Not Located
		Science Learning Center	LE-07	Copier	1	NIC	O/O	N	B	22"Lx26"Wx25"H			Not Located
		Science Learning Center	LE-08	Projector	2	NIC	O/O	N	B	19"Lx5"Wx14"H			Not Located
SA202		Science Learning Center	LE-09	Microscope	6	NIC	O/O	E	B	5"Lx6"Wx17"H			Not Located
		Science Learning Center	LE-10	Microscope	12	NIC	O/O	N	B	5"Lx6"Wx17"H			Not Located
SA202		Science Learning Center	LE-11	Slide Box	15	NIC	O/O	E	B	3"Lx4"Wx1"H			Not Located
		Science Learning Center	LE-12	Slide Box	25	NIC	O/O	N	B	3"Lx4"Wx1"H			Not Located
SA202		Science Learning Center	LE-13	Fish Tank	2	NIC	O/O	E	B	25"Lx20"Wx20"H			Not Located
SA202		Science Learning Center	LE-14	Fish Tank	2	NIC	O/O	N	B	25"Lx20"Wx20"H			Not Located

NIC	Not In Contract
N	New Equipment
E	Existing Equipment
B	Bench Top Equipment
F	Floor Mounted Equipment
WL	Wall Mounted Equipment
S	Suspended Equipment
C	Ceiling Mounted Equipment
L	Length
W	Width
H	Height
O/O	Owner Furnished / Owner Installed
C/C	Contractor Furnished / Contractor Installed
BSC	Biosafety Cabinet
ADA	Americans with Disabilities Act

SECTION 116100 - STERILIZING AND WASHING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, Section 116000 - Laboratory Equipment-General Requirements, and Drawings, apply to Work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessories, necessary to furnish, deliver and install:
   1. Autoclave
   2. Undercounter Glass Washer
   3. Pass-Through Box

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. For general requirements applicable to this and all other Laboratory Equipment Specification Sections including, but not limited to definitions, system description, submittals, quality assurance, mock-up, testing, field measurements, pre-installation conference, delivery, storage and handling, project conditions, and sequencing requirements, refer to Specification Section 116000 - Laboratory Equipment-General Requirements.

PART 2 PRODUCTS

2.1 GENERAL

A. For general requirements applicable to this and all other Laboratory Equipment Specification Sections including, but not limited to, manufacturers, materials, components, and finish and performance requirements, refer to Specification Section 116000 - Laboratory Equipment-General Requirements.

2.2 AUTOCLAVE

A. Acceptable Manufacturers & Products:
   1. Basis of design Autoclave to be model # GE-633LS, manufactured by Getinge International, Lakewood, NJ.

B. Description:
   1. Polished stainless steel medium steam, cabinet enclosed sterilizer with integral steam generator.
   2. Provide a microprocessor-controlled, automatic vacuum/gravity steam sterilizer designed to sterilize heat and moisture-stabile laboratory, research using gravity or downward displacement with positive pulsing conditioning and pressure/vacuum pulsing for dynamic air removal, and sterilize liquids in self-venting or unsealed containers using controlled exhaust for linear and consistent cool down. The temperature range shall be selectable from 110°C to 135°C, for liquid cycles from 104°C to 135°C.
   3. Type: Microcomputer controlled automatic steam sterilizer with operator selectable cycles for laboratory, scientific or general-purpose gravity or vacuum steam sterilization and decontamination of laboratory research supplies.

4. Interior Chamber Size: 26.5” L x 26.5” H x 39” D
5. The sterilizer shall be designed for free-standing installation. Stainless steel side panels shall enclose the sterilizer body and piping.
6. Each unit shall be provided with vacuum and gravity cycles for the sterilization of liquids, porous loads, and hard goods.
7. Sterilizer shall be equipped with prevacuum, gravity, liquid, leak test and daily air removal test cycles.
8. Chamber construction: The chamber shall be constructed of an inner shell and a series of “U” channels that form the outer jacket of the chamber. The gasket ring and backhead shall be formed and welded to the chamber body. Chamber material and door material are 316 stainless steel. The”U” channel material shall also be 316 stainless steel. Internal surfaces shall be high polished to facilitate cleaning. All pressure vessel construction meets ASME code requirements for pressures up to 45 psig and full vacuum. The gasket ring holds a continuous, one-piece silicone gasket, 0.63” in diameter, which shall be replaceable. A steam baffle shall be provided to prevent condensation from wetting the load. An extra threaded opening shall permit passage of thermocouple leads to monitor interior and load temperatures. The steam connections to the “U” channels and to the chamber are 316 stainless steel. The internal corners shall be radiused to aid cleaning and the chamber floor shall slope to a central drain. A stainless steel mesh strainer shall protect the drain port from blockage by debris. The sterilizer chamber shall be completed insulated with minimum 2" chloride free mineral wool. The chamber shall be mounted on a stainless steel framework with adjustable feet.
9. Door: Provide fully automatic vertical sliding single door. Door operation shall be controlled via push buttons on the control panel. A mechanical safety shall stop the door if it is obstructed while closing. The door shall be automatically sealed at the start of a cycle. A mechanical locking bar shall provide added safety when the door is fully closed. A pressure switch shall monitor the gasket pressure throughout the process and shall initiate an alarm in the event of loss of pressure. Steam may not enter the chamber unless this switch is actuated. At the end of the process, the seal shall be withdrawn by vacuum and the door shall be opened for unloading.
10. Personnel safety features: In addition to the door safety systems, the chamber shall be provided with a pressure monitor that ensures that all chamber pressure has been relieved prior to allowing the door to open. As an "intrinsic safety" feature, when the door seal is retracted the chamber shall be completely vented to atmosphere while the door is still retained in the fully closed and mechanically locked position. The fascia temperature shall be <45ºC.
11. Safety Valve: The safety valve (ASME approved and so stamped) for pressure vessel shall be set at the approved maximum operating pressure of the vessel. Valve shall be sealed so that setting cannot be altered, and will blow down at least 2 psig before closing. Valve shall be sized so that pressure in vessel will not rise more than 10 percent over the set pressure.
12. Mechanical vacuum pump. A single stage liquid ring vacuum pump, mounted on vibration isolators for quiet operation shall be provided to effectively remove air from within the chamber.
13. Drain cooling. The drain discharge shall be indirectly cooled down to reduce the effluent temperature to 140ºF (60ºC) or less.
14. Pressure gauges for chamber pressure and jacket pressure shall be mounted in visible location.
15. Steam Source: 30kV integral steam generator with an automatic feed water pump shall be provided.
16. Temperature and pressure sensors. Each sensor shall be factory calibrated with individual constants. The pressure sensor shall be equipped with software base temperature compensation. The following sensors shall be provided and shall be used in the automatic control of the sterilizer:
17. Control system features: The control system shall be designed to control the processing equipment, and shall control all system functions and shall monitor the

operation of the sterilizer. The system shall document operations and shall provide visual indication of all operating parameters. Operating status shall be provided both visually and audibly to alert operators of cycle completion or alarm conditions.

18. Controls: Front mounted controls.
19. Water Saver Package: Sterilizer shall be provided with Water Saver Package. The system shall be adjusted properly and shall provide water savings of 75% or greater.
20. 480 VAC, 60 Hz, 3-Phase, 54 A/Phase
21. The following components, options and accessories shall also be provided.
    a. Boiler Control and Safety Device. Shall satisfy state ASME requirements for secondary low water cut-off as required by local jurisdiction.
    b. Automatic Steam Boiler Blow-down
    c. ASME Blowdown
    d. Backflow preventer
    e. Rack with two shelves
22. Meet UL and CSA codes, ASME approved.
23. Unit shall carry a one (1) year warranty for parts and labor and the ASME pressure vessel will carry a fifteen (15) year warranty for workmanship or structural failure.

2.3 UNDER-COUNTER GLASSWASHER

A. Acceptable Manufacturers & Products:
1. Basis of design Glasswasher to be model # G 7883, manufactured by Miele, Princeton, NJ.

B. Description:
1. The Glassware Washer shall be a cabinet-type washer with completely automatic solid-state circuitry that monitors and controls all cycle phases. Washer shall be mounted under a counter.
2. Glassware Washer for 208/220V, 60Hz, 30A operation.
3. Size: Exterior dimensions: 23.5” W x 23.5” D x 33.5” H
4. Chamber load capacity: 20.5” W x 20.5” D x 18.5” H
5. Door: Sterilizer door shall lock automatically and cannot be opened until pressure is exhausted.
6. Construction:
    a. Interior: Chamber walls and ceiling shall be constructed of type 304 stainless steel. Chamber floor and door shall be constructed of type 316 stainless steel. All surfaces shall be polished for increased corrosion-resistance.
    b. Exterior cabinet shall be constructed of type 304 brushed stainless steel. Space frame construction shall allow easy removal of side and top panels for service, and recycling at end of machine life
7. Wash Programs shall include five factory preset programs minimum (RINSE ONLY, PLASTIC, GLASS, GLASS PLUS AND SCIENTIFIC) and two user set programs (USER 1 SET and USER 2 SET).
8. Final DI Rinse shall be provided.
9. Controls: Front mounted controls.
10. Temperatures: Wash and final rinse adjustable up to 93ºC maximum temperature. Temperature shall be monitored by dual sensors.
11. Heaters: Heater to boost water and glassware temperatures during washing and drying shall be provided. Minimum inlet temperature of 120° F.
12. Provide with built-in top and bottom spray arms.
13. Provide unit with a standard steam condenser.
14. The following Racks, Inserts and Accessories shall be provided:
    a. Adjustable height top rack.
    b. Bottom rack.
    c. Half injector basket shall include 7 (0.16”) high injectors and 9 (0.22”) high injectors. Half of rack shall be open grid for placing various inserts, baskets, and large items.

d. Half insert, 3 rows of 0.14” high tall holders for 21 beakers or other glassware.
e. Half insert, mesh basket.

15. Standards and Codes: Meet UL codes, ASME approved

C. PASS-THROUGH BOX

1. Acceptable Manufacturers and Products:
   a. Terra Universal, Fullerton, CA (Model No. 2636-06C)
   b. TBJ Incorporated, Chambersburg, PA.
   c. Air Energy Systems, Indianapolis, IN.
2. Description:
   a. Pass-through cabinet, including cabinet, all hardware, support brackets, and accessories shall be constructed of minimum 16 gauge stainless steel.
   b. Two mechanically interlocked (only one door can be opened at a time) doors with tempered glass set in stainless steel frame, heavy duty quick release handles and closed cell neoprene gasket door seals.
   c. Two stainless steel mounting angles with mitered corners for framing both sides of wall opening.
   d. Provide stainless steel key lock on one door, on corridor side.
   e. Pass-through cabinet shall be 24”W x 24”H x 24”D clear inside dimensions with chamber bottom mounted 36” AFF.
   f. 3/8” thick tempered glass view panes.
   g. Complete with stainless steel sloped top.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. For General Installation Requirements applicable to this and all other Laboratory Equipment Specification Sections including, but not limited to, examination, installation, adjusting, cleaning, and protection requirements, refer to Specification Section 116000 - Laboratory Equipment-General Requirements.

END OF SECTION 116100

SECTION 116500 - MISCELLANEOUS LABORATORY EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, Section 116000 - Laboratory Equipment-General Requirements, and Drawings, apply to Work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessories, necessary to furnish, deliver and install:
1. DI Polishers
2. Ice Makers
3. Explosion Proof Refrigerator

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. For general requirements applicable to this and all other Laboratory Equipment Specification Sections including, but not limited to definitions, system description, submittals, quality assurance, mock-up, testing, field measurements, pre-installation conference, delivery, storage and handling, project conditions, and sequencing requirements, refer to Specification Section 116000 - Laboratory Equipment-General Requirements.

PART 2 PRODUCTS

2.1 GENERAL

A. For general requirements applicable to this and all other Laboratory Equipment Specification Sections including, but not limited to, manufacturers, materials, components, and finish and performance requirements, refer to Specification Section 116000 - Laboratory Equipment-General Requirements.

2.2 DI POLISHERS

A. Acceptable Manufacturers & Products:
1. Millipore Corp. Marlborough, MA (Milli-Q Advantage A10)
2. Sartorius, Edgewood, NY.
3. Barnstead/Thermollyne, Dubuque, Iowa.

B. Description:
1. The point of use ultra-pure water system with ultrafilter and UV lamp shall provide type I, 18 meg-ohm quality water with </=5 ppb TOC and <0.001 EU/mL pyrogen levels, at locations indicated on drawings.
2. The unit shall be provided complete with Remote Dispenser.
3. Feed Water: RO/DI water.
4. The system shall have a flow rate of up to 2 liters/minute.
5. The system shall be provided with point-of-use filters designed for UF, bacteria removal, or liquid chromatography applications. The system shall also include a 2 years life time built-in UV lamp with emission at 185 & 254 nm wavelength.
6. The system shall be installed complete with interconnecting plumbing and electrical work per the drawings and specifications.
7. The vendor shall supply all of the major system components and necessary cartridges.
8. The system shall be a virtually silent unit, generating less than 40 decibels at a 1 meter distance from the system.

9. It shall be wall mounted without the addition of any special brackets and it shall come complete with a remote dispenser to allow delivery of water.
10. The unit shall be have a microprocessor controlled purity monitor and controls for simple and accurate operation.
11. Overall Dimensions: Width: 13”W x 14 ¼”D x 19.5”H
12. The unit shall be provided with one remote dispensing arm for final polishing at the point of use polisher that delivers ultrapure water adapted to specific needs. The polisher shall be capable of connecting up to three remote dispensing arm units to be used at different locations within the same laboratory.
13. The remote dispensing arm unit shall have a colored graphic display to allow easy interaction with the system and provides information about water quantity and quality. It shall also display system operation details and performance for managing routine maintenance and procedures.
14. The remote dispensing arm unit shall be capable to operate at a distance of 9 feet away from production unit. It shall be able to adjust up and down to fit different size glassware in the lab, along with being able to rotate left and right.
15. Remote Dispensing Arm Unit Dimensions: 9.0”W x 22 ¾”H

2.3 ICE MAKERS

A. Acceptable Manufacturers & Products:
1. Scotsman Ice Systems, Vernon Hills, IL (Model # FME504AS-1A with HTB555-H Storage Bin).
2. Hoshizaki America, Inc., Peachtree City, GA
3. Ice-O-Matic, Denver, CO

B. Description:
1. Self Contained Flaker with Storage Bins & 6” high legs.
2. Air-cooled flaker with removable, cleanable air filters for more efficient operation and dependable performance.
3. Durable, high grade stainless steel construction.
4. Up to 450 lbs. ice production per 24 hours.
5. Corrosion-resistant stainless steel exterior.
6. Storage Bin Capacity: 500 lbs.

2.4 EXPLOSION PROOF REFRIGERATOR

A. Acceptable Manufacturers & Products:
1. VWR, Arlington Heights, IL (Model # 55703-442).
2. Thermo Scientific, Waltham, MA
3. Electrolux Martinez, GA (Kelvinator Scientific)

B. Description:
1. Explosion Proof refrigerators shall meet operation temperature code: T5, Class I Group C&D and meet the requirements of OSHA 29 CFR 1910.307.
2. Capacity: 27.3 cu. ft.
3. Cabinets shall offer a temperature range of 4°C to -23°C.
4. Units shall have adjustable cantilever shelves.
5. No-spark interiors.
6. Solid urethane foam insulated doors with built-in keylocks.
7. Cabinet construction shall be of heavy gauge cold rolled steel for the exterior and galvalume on the interior. Urethane insulation shall bind the inner and outer walls into single unit.
8. Interior and exterior surfaces shall be finished with high luster powder coat.
9. Colored front door label shall indicate explosion proof cabinet safety coverage.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. For General Installation Requirements applicable to this and all other Laboratory Equipment Specification Sections including, but not limited to, examination, installation, adjusting, cleaning, and protection requirements, refer to Specification Section 116000 - Laboratory Equipment-General Requirements

END OF SECTION 116500

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Manually operated sunscreen roller shades.
2. Manually operated room-darkening shades.
3. Electrically operated room-darkening shades.
4. Electrically operated double-roller sunscreen and room-darkening shades.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

C. Scope:

1. Provide roller shades in locations as indicated on the drawings, and per the schedule at the end of this section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, 10 inches long.

D. Samples for Initial Selection: For each type and color of shadeband material.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of roller shade.

1. Shadeband Material: Not less than 10 inches square. Mark inside face of material if applicable.
2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
3. Installation Accessories: Full-size unit, not less than 10 inches long.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material, signed by product manufacturer.

C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roller shades to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hunter Douglas Contract.
2. Lutron Electronics Co., Inc.
3. MechoShade Systems, Inc.

B. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: Stainless steel.

a. Loop Length: Full length of roller shade.
b. Limit Stops: Provide upper and lower ball stops.
c. Chain-Retainer Type: Chain tensioner, jamb mounted.

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller-shade weight and lifting heavy roller shades.

a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criteria are more stringent.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Direction of Shadeband Roll: Regular, from back of roller.
2. Shadeband-to-Roller Attachment: Removable spline fitting integral channel in tube.

C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

E. Shadebands:

1. Shadeband Material: Light-filtering fabric or Light-blocking fabric as selected from manufacturer’s full range.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: Enclosed in sealed pocket of shadeband material.
b. Color and Finish: As selected by Architect from manufacturer's full range.

F. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.

   a. Shape: L-shaped.
   b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

   a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open.

3. Endcap Covers: To cover exposed endcaps.
4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.

   a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open.

5. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
6. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
7. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 MOTOR-OPERATED ROLLER SHADES

A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. System Type: Motorized interior room darkening blackout roller shades, or “double”, solar and room darkening blackout roller shades, operating independently of each other.
2. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Electric Motor: Manufacturer's standard tubular, enclosed in roller.

   a. Electrical Characteristics: Single phase, 110 V, 60 Hz.

4. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:

   a. Individual Switch Control Station: Momentary-contact, five-position, rocker-style, wall-switch-operated control station with open, close, and center off functions.

b. Color: As selected by Architect from manufacturer's full range.
c. Control system shall allow for automatic alignment of shade hem bars in stopped position at 25 percent, 50 percent, and 75 percent of opening heights, and up to three user-defined intermediate stopping positions in addition to all up / all down, regardless of shade height, for a total of five positions. Control system shall allow shades to be stopped at any point in the opening height noting that shades may not be in alignment at these non-defined positions).
d. Control system shall have two standard operating modes: Normal mode allowing the shades to be stopped anywhere in the window's opening height and uniform mode, allowing the shades to only be stopped at the predefined intermediate stop positions. Both modes shall allow for all up / all down positioning.

5. Limit Switches: Adjustable switches, interlocked with motor controls and set to stop shade movement automatically at fully raised and fully lowered positions.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Direction of Shadeband Roll: Regular, from back of roller.
2. Shadeband-to-Roller Attachment: Manufacturer's standard method.

C. Shadeband Retention System: Manufacturer's standard system for guiding shadeband through range of travel and holding shadeband taut with edges of shadeband supported by side channels or angles.

D. Mounting Hardware: Corrosion resistant and compatible with operating mechanism, installation accessories, and mounting location and conditions indicated.

E. Shadebands:

1. Shadeband Material: Light filtering shade and Light-blocking fabric as selected form manufacturer's ful range.
2. Shadeband Bottom (Hem) Bar: Manufacturer's standard for operating mechanism indicated.

a. Color and Finish of Exposed Bottom Bar: As selected by Architect from manufacturer's full range.

F. Installation Accessories:

1. Exposed Headboxes and Bottom Boxes: Rectangular, extruded-aluminum enclosure including front fasciae, top and back covers, endcaps, and removable closures.

a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open.

2. Channels or Angles: Manufacturer's standard design for operating mechanism indicated and shadeband take-up and support.
3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.

1. Source: Roller-shade manufacturer.
2. Type: Woven polyester and PVC-coated polyester.
3. Weave: Mesh.
4. Thickness: 0.018 inches.
5. Orientation on Shadeband: Up the bolt.
6. Openness Factor: As selected.
7. Color: As selected by Architect from manufacturer's full range.

C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.

1. Source: Roller-shade manufacturer.
2. Type: Woven polyester and PVC-coated polyester.
3. Thickness: 0.018 inches.
4. Orientation on Shadeband: Up the bolt.
5. Features: Washable, Antistatic treatment.
6. Color: As selected by Architect from manufacturer's full range.

2.5 ROLLER-SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
2. Skylight Shades: Provide battens and seams at uniform spacings along shadeband as required to ensure shadeband tracking and alignment through its full range of movement without distortion or sag of material.
3. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

PART 4 - SHADE SCHEDULE

A. Manually operated room-darkening shades with light-blocking fabric at all exterior glazing in all rooms with projection screens.

B. Electrically operated room-darkening shades for curtain wall type MM in the light monitors in the Meeting room and SLC.

C. Electrically operated double-roller sunscreen and room-darkening shades in Conference room 200.

D. Manually operated sunscreen roller shades at all other exterior window locations excepting the following:

1. Stairwells.
2. Building entrances.
3. Corridors 146Z.
4. Corridors 151Z.
5. Atrium clerestory.

END OF SECT ION 122413

SECTION 123090 - LABORATORY SERVICE FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, Specification Section 123400 – Laboratory Casework-General Requirements, and Drawings apply to work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessories, necessary to furnish, deliver and install:
1. Domestic Hot And Cold Water Fixtures
2. Ultra-Pure Water Fixtures
3. Laboratory Gas Fixtures
4. Electrical Service Fixtures
5. Data Outlets
6. Fume Hood Service Fixtures
7. Eye Wash/Drench Hose
8. Barrier-Free Recessed Safety Station With Drain Pan

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. For general requirements applicable to this and all other Casework Specification Sections including, but not limited to definitions, system description, submittals, quality assurance, mock-up, testing, field measurements, pre-installation conference, delivery, storage and handling, project conditions, and sequencing requirements, refer to Specification Section 123400 - Laboratory Casework-General Requirements.

E. Products Specified But Not Installed Under This Section:
1. Section 123450 – Metal Laboratory Casework and Fume Hoods: Factory installation of laboratory service fixtures in fume hoods

F. Related Sections:
1. Section 123400 - Laboratory Casework - General Requirements
2. Section 123450 - Metal Laboratory Casework and Fume Hoods: Fixture mounting holes
3. Section 123460 - Wood Laboratory Casework: Fixture mounting holes
4. Division 22 - Mechanical: Connection of laboratory service fixtures to service lines
5. Division 26 - Electrical: Connection of laboratory service fixtures to service lines
6. Division 27 - Data: Connection of data outlets to service lines

PART 2 PRODUCTS

2.1 GENERAL

A. For general requirements applicable to this and all other Casework Specification Sections including, but not limited to, manufacturers, materials, components, and finish and performance requirements, refer to Specification Section 123400 - Laboratory Casework-General Requirements

2.2 MANUFACTURED UNITS

A. Plumbing Fixtures:
1. Heavy duty special design manufactured for laboratory use

2. Provide with mounting shank of length and type suitable for substrate condition, lock nut, and other mounting devices necessary for attachment to countertops, backsplashes, and panels
3. Factory assemble fixtures with valves and mounting shanks
4. Individually factory pressure-tested
5. Fixture shipment: Provide fixtures loose, except for factory-mounted fixtures in fume hoods specified in Section 123450
6. Fabricate to accommodate index coding
7. Provide fixtures with colored service identification:
   a. Fitting handles: Handles with lettered and color-coded index buttons to identify services:

Domestic hot water:	HW	Red
Domestic cold water:	CW	Green
Laboratory compressed air:	A	Orange
Laboratory (natural) gas:	G	Blue
Laboratory vacuum:	V	Yellow
Nitrogen	N	Brown
Helium	He	Black
Ultra-pure water:	DI	White

2.3 DOMESTIC HOT AND COLD WATER FIXTURES

A. Acceptable Manufacturers:
   1. Water Saver Faucet Company, Chicago, IL
      a. Deck Mounted Hot and Cold Water Mixing Faucet with 8” swing type gooseneck with vacuum breaker - Model No. L412VB.
      b. Deck Mounted Cold Water Faucet with 8” swing type gooseneck with vacuum breaker - Model No. L612VB.
      c. Deck Mounted Hot and Cold Water Mixing Faucet with 8” swing type gooseneck with vacuum breaker & wrist blade handles for ADA sinks - Model No. L412VB-BH.
      d. Deck Mounted Turret Base with Single Outlet Cold Water Valve with vacuum breaker and serrated hose end - Model No. L2800-110-131WSA.
      e. See Article 2.5 for Quick Connect Assemblies for ADA workstation
   2. Chicago Faucets, Des Plaines, IL
   3. Kewaunee Scientific Corporation, Statesville, NC

B. Description:
   1. Design for maximum operating water pressure of 550 kPa (80 psi)
   2. Made of chrome plated brass with an 8" spread swing gooseneck.
   3. Removable straight serrated hose connector.
   4. Provide with integral vacuum breaker on goosenecks to prevent backflow. Vacuum breakers shall be designed specifically for laboratory applications. As such, they shall be design to seal properly and prevent spillage under extreme low flow conditions.
   5. Valves shall be disc type with renewable internal assemblies.
   6. Forged brass four-arm handle for ease of griping and turning. Furnished with full view color-coded index disc secured with cement.
   7. Provide forged brass wrist blade handles with colored plastic index disc at ADA sinks.
   8. Individually factory test prior to shipment
   9. All faucets shall meet the requirements of ANSI/ASME A112.18.1M
   10. Vacuum breakers shall be certified by the American Society of Sanitary Engineers (ASSE) under ASSE Standard No. 1001.

2.4 ULTRA-PURE WATER FIXTURES

A. Acceptable Manufacturers:
   1. Water Saver Faucet Company, Chicago, IL

a. Deck Mounted Pure Water Faucet with All-Polypropylene Internal Construction - Model No. L7833.
b. Deck Mounted Turret Base with Single Outlet Pure Water Valve with serrated hose end with All-Polypropylene Internal Construction - Model No. L72800-7131PP-WSA.

2. Chicago Faucets, Des Plaines, IL
3. Hydro Service and Supplies, Inc., Research Triangle Park, NC

B. Description:
1. Design for maximum operating water pressure of 50 psi
2. Ultra-pure water fixture shall be 6" rigid gooseneck with serrated hose connector
3. All components in contact with pure water shall be polypropylene
4. 3/8" I.P.S. brass riser with polypropylene lining
5. Forge brass valve body with polished chrome plated finish, and with polypropylene interior
6. Round white nylon handle with white index disc
7. No additives, glues or pipe sealants, which may leach contaminants, shall be used

2.5 QUICK CONNECTS FOR ADA WORKSTATION

A. Acceptable Manufacturers:
1. Water Saver Faucet Company, Chicago, IL
a. H&CW Service Panel Mounted Hot and Cold Water Fitting with vacuum breaker and Quick-Disconnect, ADAAG compliant:
Flange body for fixed casework panel and brass keyed quick connect plug:
B-QC6-F-6PM-K#
Quick connect stem with internal shut-off valve:
B-QC6-D-6PM-K#
6 ft. reinforced PVC Hose color-coded per service.
b. G, V & A Service Panel Mounted Gas, Vacuum and Air Fittings with Quick-Disconnect, ADAAG compliant:
Flange body for fixed casework panel and brass keyed quick connect plug:
B-QC6-F-6PM-K#
Quick connect stem with internal shut-off valve:
B-QC6-D-6PM-K#
6 ft. reinforced PVC Hose color-coded per service.
c. ADA workstation drain hose assembly
84" Braided stainless steel hose with 1" NPT Female CAM Lever coupling assembly and 1 ½" NPT female adapter:
S1480A-084
2. Chicago Faucets, Des Plaines, IL
3. Kewaunee Scientific Corporation, Statesville, NC

2.6 LABORATORY GAS FIXTURES

A. Acceptable Manufacturers:
1. Water Saver Faucet Company, Chicago, IL
a. Deck Mounted Fixtures with removable serrated hose ends

Single Outlet Turret	Model No. L4200-131WSA
Two-way Outlet Turrets at 90°	Model No. L4200-132AWSA
Two-way Outlet Turrets at 180°	Model No. L4200-132SWSA

b. Panel Mounted Fixture with removable serrated hose end

Single Outlet Turret	Model No. L4200

c. See Article 2.5 for Quick Connect Assemblies for ADA workstation
2. Chicago Faucets, Des Plaines, IL
3. Kewaunee Scientific Corporation, Statesville, NC

B. Description:
1. Laboratory Ball Valves:
a. On/off control of gas, air or vacuum at pressures up to 75 psi
b. Valve Body: Forged brass with polished chrome plated finish
c. Valve Unit: Quarter-turn open/close with chrome plated brass ball and molded TFE seals
d. Handle: Forged Brass lever handle with color-coded index disc to indicate service
2. Hose end:
a. Removable, serrated, non-slip
b. Straight, unless otherwise indicated
c. Quick disconnect at wall mounted laboratory fixtures
3. Provide with cylindrical turret with single or double outlets, as shown on drawings
4. Provide ADA compliant lever handle at ADA workstations
5. Provide fine control needle valves for nitrogen, helium and other special gas services at pressures over 75 psi.
6. Fixture shall be fully assembled and factory tested prior to shipment

2.7 ELECTRICAL SERVICE FIXTURES

A. All electrical outlets to be provided under Division 26 – Electrical, unless noted otherwise

B. Provide electrical wrinkled black, epoxy powder coated pedestals with enclosure boxes, receptacles, and stainless steel cover plates as follows:
1. Deck Mounted, Single Faced, Single Wide, Pedestal Box (Kewaunee Model # W-0581-2V).
2. Deck Mounted, Double Faced, Single Wide, Pedestal Box (Kewaunee Model # W-0581-3V).
3. Deck Mounted, Double Faced, Double Wide, Pedestal Box (Kewaunee Model # W-0581-8V).

2.8 DATA SERVICE OUTLETS

A. All data outlets to be provided under Division 27 – Telecom/Cabling Systems, unless noted otherwise

B. Provide Data wrinkled black, epoxy powder coated pedestals with enclosure boxes, receptacles, and stainless steel cover plates as follows:
1. Deck Mounted, Single Faced, Single Wide, Pedestal Box (Kewaunee Model # W-0581-2V).
2. Deck Mounted, Double Faced, Single Wide, Pedestal Box (Kewaunee Model # W-0581-3V).

2.9 FUME HOOD SERVICE FIXTURES

A. Acceptable Manufacturers:
1. Kewaunee Scientific Corporation, Statesville, NC
(Model numbers indicated below are by Kewaunee unless noted otherwise)
Remote Control Cold Water Fixture
Model No. W-0740-L/R-CW-I-X
Remote Control Laboratory Gas Fixtures
Air Model No. W-0739-L/R-AIR-I
Gas Model No. W-0739-L/R-GAS-I
Vacuum Model No. W-0739-L/R-VAC-I
Electrical Fixtures for mounting in Fume Hoods Model No. 0581-1V-I
Toggle Switch for Fume Hoods Model No. 0655-1V-I
2. Chicago Faucets, Des Plaines, IL
3. Water Saver Faucet Company, Chicago, IL

B. Remote Control Cold Water Fixtures:
   1. Design for maximum operating water pressure of 550 kPa (80 psi)
   2. Front loaded fittings including brass valve with replaceable seat, nylon color coded panel flange with angle serrated hose connector
   3. Cold Water Gooseneck
   4. Fume Hoods shall be pre-piped as specified in Section 123450

C. Remote Control Laboratory Gas Fixtures:
   1. On/off control of gas, air or vacuum at pressures up to 40 psi
   2. Remote Control Ball Valve with Extension Rod, Guide Plate and Handle. Valve shall be certified for gas service by the American Gas Association (AGA)
   3. Front loaded fittings including brass valve with replaceable seat, nylon color coded panel flange with angle serrated hose connector
   4. Fume Hoods shall be pre-piped as specified in Section 123450

D. Remote Control ADA Compliant Laboratory Gas and Water Fixtures:
   1. Remote control laboratory ball valve with guide plate, rod and handle for water and gas services
   2. Valve shall be factory assembled and tested at 125 psi. Maximum working pressure shall be 75 psi
   3. Valve shall be suitable for water and gas services
   4. Fume Hoods shall be pre-piped as specified in Section 123450
   5. Provide ADA compliant lever handle

E. Electrical Fixtures:
   1. Include engraved stainless steel cover plate, and receptacle
   2. Quantity and location as indicated on drawings
   3. Fume Hoods shall be pre-wired as specified in Section 123450

2.10 DECK-MOUNTED EYE WASH/DRENCH HOSE UNIT (EW)

A. Acceptable Manufacturers:
   1. Water Saver Faucet Company, Chicago, IL
      (Deck-Mounted Eye Wash/Drench Hose with vacuum breaker
      Model No. EW1022-VB-HG)
   2. Chicago Faucets, Des Plaines, IL
   3. Guardian Equipment, Chicago, IL

B. Description:
   1. Drench hose unit to rinse any part of a User's eye, face or body
   2. Provide GS-Plus spray head. Spray head shall have "flip top" dust cover, internal flow control and filter to remove impurities from the water flow
   3. Valve: Forged Brass squeeze valve activated by stainless steel lever handle. Valve shall close when handle is released
   4. Hose: 8' reinforced PVC hose. 300 psi maximum rated working pressure
   5. Mounting: Deck flange for countertop mounting
   6. Sign: ANSI-compliant identification sign
   7. Unit shall be completely assembled and water tested prior to shipment.
   8. Provide in-line vacuum breaker for installation between valve and spray head
   9. Provide under counter hose guide bracket to prevent hose from tangling or binding
   10. Comply with the requirements of ANSI Z358.1 for eyewash equipment

2.11 BARRIER-FREE RECESSED SAFETY STATION WITH DRAIN PAN

A. Acceptable Manufacturers:
   1. Water Saver Faucet Company, Chicago, IL
      (Barrier Free Recessed Safety Station with Drain Pan - Model No. SSBF2150)

2. Chicago Faucets, Des Plaines, IL
3. Guardian Equipment, Chicago, IL

B. Description:
1. Shower Head: 10 inches. Spray pattern shall be 20 inches diameter at 60 inches above floor. Furnished with stainless steel vertical supply pipe and ceiling escutcheon for mounting shower head at desired height below finished ceiling.
2. Valve: 1 inch IPS stainless steel stay-open ball valve with stainless steel "panic bar". Pulling bar down shall activate shower; shower shall remain in operation until bar is returned to original closed position. Furnished with stainless steel access panel and 1" IPS unions for valve.
3. Cover /Drain Pan: Eye/face wash section of unit shall have stainless steel cover. Opening cover shall pull outlet head assemble down from vertical to horizontal position and shall activate water flow. Horizontal grab bar shall be easily grasped and pulled in an emergency. While unit is in operation, waste water shall be collected by drain pan and returned into unit for drainage. Unit shall remain in operation until cover is returned to closed position.
4. Eye/Face Spray Head Assembly: Two spray heads mounted on supply arms. Each spray head shall have internal flow control and filter to remove impurities from water.
5. Eye/Face Wash Valve: ½" IPS brass stay-open ball valve.
6. Mounting: Entire unit shall be enclosed in an 18 gauge stainless steel cabinet with flanged rim for recessed mounting in wall. Combination cover and drain pan shall be 18 gauge stainless steel. Unit shall fit in standard 3 5/8" deep wall
7. Pipe and Fittings: All pipe and fittings shall be stainless steel or brass.
8. Individually factory test prior to shipment.
9. ANSI-compliant identification sign.
10. Comply with the requirements of ANSI Z358.1 for eyewash equipment

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. For General Installation Requirements, applicable to this and all other Casework Specification Sections including, but not limited to, examination, installation, adjusting, cleaning, and protection general requirements, refer to Specification Section 123400 - Laboratory Casework-General Requirements.

3.2 ADDITIONAL INSTALLATION REQUIREMENTS

A. Install in accordance with specifications

B. Install items plumb, level and square

C. Maintain dimensional tolerances and alignment with surrounding construction and adjacent surfaces

D. Interface With Other Work. Install items in a sequence to not delay:
1. Adjoining construction
2. Connections of casework and hoods to mechanical and electrical services

END OF SECTION 123090

SECTION 123400 - LABORATORY CASEWORK – GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. The casework contractor shall furnish and install all products specified herein and in the complete casework package. The complete casework package consist of the following specification sections:
   1. Section 123090 - Laboratory Service Fixtures
   2. Section 123400 - Laboratory Casework - General Requirements
   3. Section 123450 - Metal Laboratory Casework and Fume Hoods
   4. Section 123460 - Wood Laboratory Casework
   5. Section 123470 - Polypropylene Laboratory Casework

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessories, necessary to furnish, deliver and install:
   1. Epoxy Resin Countertops, Back Splashes, Sinks and Cup Sinks
   2. Stainless Steel Countertops, Back Splashes and Sinks
   3. Peg Boards
   4. Hardware and Trim
   5. Gas Cylinder Supports

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. This Section also includes all general requirements, applicable to this and all other Casework Specification Sections including, but not limited to:
   Definitions
   System description
   Scope
   Submittals
   Quality assurance
   Mock-up
   Testing
   Field measurements
   Pre-installation conference
   Delivery, storage and handling
   Project conditions
   Sequencing
   Materials
   Components
   Finish and performance requirements
   Examination, Installation, Adjusting, Cleaning and Protection Requirements

E. Related Sections:
   1. Division 07 - Sealants
   2. Division 11 - Laboratory Equipment
   3. Divisions 22 & 23 - Mechanical: service lines, plumbing connections, drains, traps, overflows, strainer, tailpieces, and fittings, ductwork, blowers, fume hood fans, and air flow monitors
   4. Division 26 - Electrical: Service lines, electrical rough-in, connections, receptacles, and covers.

1.2 DEFINITIONS

A. Service Fixtures:
   1. Plumbing Service Fixtures: Gas, air, vacuum and specialty gas cocks; ball turrets; hot, cold, and ultra-pure water gooseneck faucets; remote control valves; safety eyewash; shower heads; and other fittings.
   2. Electrical Service Fixtures: Electrical convenience outlet boxes, electrical pedestals, single or duplex receptacles, switches: etc.
   3. Other items which serve as functional part of equipment.

B. Service Lines:
   1. Gas, air, and vacuum piping; hot, cold, and deionized water piping; drain and vent lines; fittings; and control and shut off valves; to carry respective services from building roughing-in floors and walls through equipment to service fixtures.
   2. Conduit, junction boxes, conduit fitting, wire disconnect switches, fuses, and circuit breakers, to carry electrical services from building roughing-in outlets in floors, and walls through equipment to service fixtures.

C. Exposed:
   1. As used in this Specification Section, "exposed" portions of woodwork include surfaces visible when doors and drawers are closed. Bottoms of woodwork more than 4 feet above finish floor are considered exposed. Visible surfaces in open casework or behind clear doors also are considered as exposed.

D. Semi-Exposed:
   1. As used in this Specification Section, "semi-exposed" portions of woodwork include those members behind opaque doors, such as shelves, divisions, interior faces of ends, case backs, drawer sides, backs and bottoms, and back face of doors. Tops of cases 6'-6" or more above finish floor shall be considered semi-exposed. Bottoms of woodwork less than 4 feet above finish floor are considered semi-exposed. Semi-exposed portions of woodwork shall be of same species, finish and color as the "exposed" portions.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Manufacturer is responsible for:
      a. Designing, engineering, fabricating, and installing system
      b. Anchorage to structure
      c. Modifications to meet specified requirements and maintain visual design concepts
   2. Drawings are diagrammatic and are intended to establish basic dimension of units, sight lines, and unit profiles.
   3. Provide concealed fastening wherever possible.
   4. Attachment considerations: Account for site peculiarities, expansion and contraction movements, so there is no loosening, weakening, and fracturing, of connections between units and substrate.
   5. Comply with UL 544 for electrically powered equipment.

B. Interface With Adjacent Systems:
   1. Coordinate with mechanical service lines and ductwork.
   2. Coordinate with electrical service lines.

1.4 SCOPE

A. Furnish and install all cabinets and casework, including tops, ledges, supporting structures, fume hoods, laboratory sinks, cup sinks, and miscellaneous items of equipment as listed in these specifications, including delivery to the building, setting in place, leveling, scribing to walls and floors as required. Furnishing and installing all filler panels, knee space panels and scribes as shown on drawings.

B. Furnish and deliver all utility service outlet accessory fittings, as listed in these specifications or as shown on drawings as mounted on the laboratory furniture. The above defined items shall be furnished unassembled with supply tank nipples and lock nuts, not attached, loose in boxes and properly marked for delivery to the mechanical contractor. All plumbing fittings shall be packaged separately and properly marked for delivery to the appropriate contractor.

C. Furnish and deliver, packed in boxes for installation by the mechanical contractor, all drain troughs and sink outlets with integral tailpieces, which occur above the floor, and where these items are part of the equipment or listed in the specifications, or shown on the drawings. Integral tailpieces when required shall be in accordance with the manufacturer's standards. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.

D. Furnish service strip supports where specified, and setting in place service tunnels, service turrets, supporting structures and reagent racks of the type shown on the details.

1.5 SUBMITTALS

A. Product Data:
   1. Submit manufacturer's descriptive literature and product specifications for each product.
   2. Include data to indicate cabinet construction.
   3. Include information for factory finishes, chemical resistance ratings, hardware, glass, sealants, accessories, and other required components.

B. Shop Drawings:
   1. Indicate typical casework and countertop layout including dimensioned floor plans, sections and elevations, and service fixture holes locations.
   2. Indicate enclosures, cabinets, hardware, service fixtures complete with numbers and item names, and details including construction kinds of cabinets, countertops, process tables, and other components.
   3. Submit detail drawings of special accessory components not included in manufacturer's product data.
   4. Indicate joints in countertop material.

C. Samples:
   1. Work Surface Samples:
      a. One sample of all top materials shown or called for, of sufficient size to perform finish requirement tests
      b. Two pieces sealed and joined. Full depth of counter and 6 inches from each side of joint
   2. Wood Finish Sample –
      a. Include samples. Maple veneer
      b. Size: 3" x 5"
   3. Metal Casework Color Samples:
      a. Include manufacturer's full range of colors for Architect's selection.
      b. Architect will select casework components' color with no change in contract sum.
      c. Provide sample of colors, as selected by Architect, on same metal from which casework will be fabricated

d. Size: 6” x 6”

4. Sample of all mechanical service fittings, locks, door pulls, hinges, and interior hardware.

D. Certification: Submit certifications specified in Quality Assurance article.

E. Qualification Data:
1. Submit manufacturer's and installer's qualifications verifying years of experience.
2. Include list of completed projects having similar scope of Work identified by name, location, date, reference names, and phone numbers.

F. Manufacturer's Instructions: Submit manufacturer's printed installation instructions.

G. Warranty:
1. Submit specified warranty in accordance with Division 01.
2. Warrant installed casework to be free from defects in material and workmanship for 1 year from date of substantial completion.
3. Warrant casework and components to be corrosion free for 3 years from date of substantial completion.
4. Include coverage against defects which may arise during the warranty period except those which are caused by misuse.

1.6 QUALITY ASSURANCE

A. General Performance:
1. Provide certification that furniture shall meet the performance requirements described in SEFA 8.

B. Wood Casework Performance Standards:
1. Architectural Woodwork Quality Standards Illustrated. Eighth Edition, Version 1.0. Virginia: 2003. Architectural Woodwork Institute.
2. ANSI/Hardwood Plywood Veneer Association Manual Version ANSI/HPVA HP-1-2009

C. Single Source Responsibility:
1. Furnish units from one manufacturer for entire Project, unless otherwise acceptable to Architect.
2. Provide casework modules as complete units, including countertop hardware, glazing, service fixtures and accessory items necessary for proper function.
3. Provide each fume hood as a complete unit, including service fixtures specified in Section 123090 and accessory items necessary for operation.

D. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum 5 years documented experience.

E. Installer Qualifications: Acceptable to fabricator with documented experience on at least 5 projects of similar nature in past 5 years.

F. Regulatory Requirements: Ensure flammable components comply with applicable portions of local, state, and federal codes, laws, and ordinances for flame spread and smoke developed indices.

1.7 PERFORMANCE REQUIREMENTS:

A. Base cabinets shall be constructed to support at least a uniformly distributed load of 200 lbs.

per square foot of cabinet top area, including working surface without objectionable distortion of interference with door and drawer operation.

B. Base cabinet corner gussets with leveling bolts shall support 500 lbs. per corner, at 1-1/2" projection of the leveling bolt below the gusset.

C. Each adjustable and fixed shelf 4 ft. or shorter in length shall support an evenly distributed load of 40 lbs. per square ft. up to a maximum of 200 lbs., with nominal temporary deflection, but without permanent set. These requirements apply to all shelves including, but not limited to wall mounted shelves, shelves at island benches, and shelves inside cabinets.

D. Drawer construction and performance shall allow 13-5/8" clear when in an extended position and suspension system shall prevent friction contact with any other drawer or door during opening or closing. All drawers shall operate smoothly, a minimum of 10,000 cycles with an evenly distributed load of 150 lbs.

E. Swinging doors on floor mounted casework shall support 200 lbs. suspended at a point 12" from hinged side. Weight load test shall allow only a temporary deflection, without permanent distortion or twist. Door shall operate freely after test and assume a flat plane in a closed position.

F. Utility Tables (4 legged) shall support 300 lbs. per square foot

1.8 MOCK-UP

A. General: Comply with provisions of Division 01.

B. The laboratory furniture manufacturer shall erect a laboratory furniture mock-up, in the location indicated by the Architect. All components utilized shall meet the requirements of the Drawings and Specifications.

C. The manufacturer shall make adjustments necessary to meet minimum performance requirements and testing criteria specified, and obtain acceptance from Owner's Representative. Modifications to the mock-up shall be incorporated into the overall design of the project without change in contract sum. Do not proceed with shop fabrication or project installation until mock-up has been accepted by Architect.

D. Accepted mock-up establishes minimum performance standards and quality for workmanship and materials for the Project. Mock-up shall remain in designated location until all furniture is installed and approved by the Owner's Representative. Approved mock-up will be incorporated into the project.

E. Mock-up scope shall include one lab, prep room, or portion of a lab, and shall incorporate the basic elements of a lab including, but not limited to, a sink and associated counter area, base cabinets with drawers and doors, knee space, wall mounted cabinet, wall mounted shelf, flammable and acid cabinets, fume hood, and ADA service panel with all necessary surface fixtures and service connection components to make the lab function. Mock-up shall be of the same color finish selected and approved via sample process.

F. Mock-up location shall be either in a conditioned trailer remaining on site throughout the project (provided by the contractor), or in a conditioned room within the new facility agreed upon by the Owner, Architect, Contractor, and Lab Casework & Equipment Provider / Installer. Mock-up shall remain in place the duration of the project and if all components are acceptable, the mock-up is permitted to become a part of the completed work. If the mock-up is located within a trailer, the components, if approved, may be relocated in the new facility

at a time approved by the Architect.

1.9 TESTING

A. The laboratory furniture manufacturer shall be required to submit with their bid certified test reports on the laboratory casework finish, all work top materials to be furnished, and hoods. These test reports shall be performed by an independent nationally recognized testing laboratory and shall certify that the materials to be supplied will conform to the requirements of these specifications as well as testing procedures. Failure to include these test reports with the bid might be cause for rejection of the bidder and of the bid proposal.

1.10 FIELD MEASUREMENTS

A. It is the laboratory furniture manufacturer's responsibility to verify all field measurements and that all equipment will fit through entry ways, corridors and door openings enabling a smooth flow of equipment to its proper location in the building.

B. Drawings show arrangement and location of casework. If it is necessary to vary from arrangement shown, because of structural, mechanical, electrical or other considerations make such variations only after approval of Architect and at no additional expense to Owner.

C. Measure all recesses and openings at buildings and provide all trim pieces, fillers, and closures, in sizes required.

1.11 PRE-INSTALLATION CONFERENCE

A. Conduct pre-installation conference in accordance with Division 01.

B. Convene pre-installation conference one week prior to commencing work of this Section.

C. Attendance Required: Owner, Architect, Contractor, Manufacturer's Representative, and Installer.

D. Agenda: Discuss and agree upon acceptable substrate and support conditions, preparatory work, interface with mechanical and electrical services, and methods of installation and testing.

1.12 PROJECT CONDITIONS

A. Environmental Requirements: Comply with manufacturer's written requirements for installing sealants.

B. Do not deliver or install casework until the following conditions have been met:
   1. Windows and doors are installed and the building is secure and weather-tight.
   2. Ceiling, overhead ductwork and lighting are installed.
   3. All painting is completed and floor tile is installed.
   4. Do not deliver or install wood product until Interior building temperature is maintained between 65 and 80 degree F, and ambient relative humidity maintained between 25% and 55% prior to delivery, and during and after installation. Frequent and/or excessive changes in temperature and/or humidity levels during casework installation, or once casework is installed, must be avoided to prevent damage to materials.

1.13 SEQUENCING

A. Sequence work under provisions of Division 01.

B. Coordinate with plumbing rough-in requirements specified in Division 22.

C. Coordinate with mechanical requirements specified in Division 23.

D. Coordinate with electrical rough-in requirements specified in Division 26.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The specific requirements shown and specified are indicated to establish a standard of design and quality for materials, construction, size and workmanship.

B. Acceptable Manufacturers. As noted for individual sections and as follows:
   1. Epoxy Resin Countertops, Sinks, Cup Sinks and Peg Boards:
      a. The Durcon Company, Canton, MI
      b. Kewaunee Scientific, Statesville, NC
      c. Thermo Scientific ALC, Austin, TX
   2. Stainless Steel Countertops and Sinks:
      a. Kewaunee Scientific, Statesville, NC
      b. Thermo Scientific ALC, Austin, TX
      c. Jamestown Metal Products Inc., Jamestown, NY
   3. Gas Cylinder Supports:
      a. Lab Safety Supply, Janesville, WI
         Wall mounted bracket: Model # 8446
         Bench mounted bracket: Model # 9417
      b. Kewaunee Scientific, Statesville, NC
      c. Thermo Scientific Hamilton, Two Rivers, WI

C. The Naming of manufacturer(s) and designation of product (s) is for the purpose of identifying and describing required product and not to limit competition. Other manufacturers capable of producing the same appearance and having the same quality, durability, and performance may be proposed for use on this project subject to Architect's approval.

D. Other approved manufacturers are responsible for all adjustments required to fit their products to the work at no additional cost.

2.2 MATERIALS

A. Solid Wood:
   1. Exposed solid wood: Select White Maple Lumber, clean and free of defect.
   2. Interior solid wood: Sound hardwood of selected species suitable for intended purpose.
   3. All lumber kiln dried to uniform moisture content of six percent.

B. Exterior Plywood:
   1. Maple and Hardwood (Maple faced poplar) Plywood: Balanced construction of cross and face-plies glued with water resistant resin glue.
   2. Maple Veneer: Quarter sliced maple veneer on all exposed faces. Vertically matched.
   3. MDF / Particle Board is not acceptable.

C. Interior Plywood:
   1. All interior plywood used in cabinets and cases, unexposed, shall be clear hardwood Grade A veneer face, Grade 2 back. All interior plywood shall have high grade, clear veneers and assembled with poly-vinyl emulsion glue. All interior unexposed shelves shall be 7-ply hardwood plywood, maple banded.

D. Cold Rolled Steel:
   1. Cold rolled sheet steel shall be prime grade U.S. Standard; roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches or other injurious effects.
   2. No less than 25% of the steel by weight shall be recycled material.

E. Galvanized Steel:
   1. Galvanized steel shall be hot dipped, extra smooth, G90, and shall be free of scale, ragged edges, deep scratches or other injurious effects.

F. Glue: Type 2 or Type 3 water resistant glue.

G. Edgebanding: 1/8" hardwood on all edges of doors and drawers; fronts of shelves, base, wall, upper and tall cases.

H. Epoxy Resin:
   1. Modified epoxy resin compounded and cured for optimum physical and chemical resistant properties.
   2. Uniform mixture throughout full thickness.
   3. Non-glaring sheen.
   4. Color: Black.
   5. Countertop and back splash thickness: 1 inch
   6. Slab flatness: No gap exceeding 0.09 inches in 96 inch span, measured in an unrestrained condition.

I. Glass:
   1. Type: Laminated safety glass.
   2. Color: Clear.
   3. Thickness: 1/4 inch nominal
      a. Outer light: 1/8 inch
      b. Plastic innerlayer: 0.030 inch polyvinylbutyral, clear
      c. Inner light: 1/8 inch
   4. Glass used for unframed sliding doors shall be ¼" float glass.

J. Epoxy Resin Cement:
   1. Suitable for use in joining sections of epoxy resin countertop, backsplashes, and sinks.
   2. Sufficient adhesion properties at temperatures 40 degrees to 100 degrees Fahrenheit for permanently anchoring epoxy resin countertops to base cabinets.
   3. Chemical resistance equal to that specified for epoxy resin countertops and sinks.
   4. Loss of hardness and adhesion properties at temperatures in excess of approximately 140 degrees Fahrenheit.
   5. Color to match epoxy resin countertops and sinks.

K. Silicone Sealant: Comply with requirements for Silicone Sanitary Sealant specified in Division 07.

L. Galvanizing Touch-up Paint: SSPC Paint 20.

M. Stainless Steel Sheet Panels:

1. ASTM A167
2. UNS Number S30200 or S30400 and S31603 (316L)
3. Location:
    a. Countertops win integral sinks and back splashes (S31603)
    b. Base and Wall Cabinets (S30200 or S30400)

N. Stainless Steel Tubing:
1. ASTM A554
2. UNS Number S30200 or S30400

O. Stainless Steel Bars and Shapes:
1. ASTM A276
2. UNS Number S30200 or S30400

P. Sound Deadening: Heavy bodied resinous coating, with resilient filler material, compounded for permanent, non-flaking adhesion to metal in 1/8 inch thick coating.

2.3 FABRICATION

A. General Requirements:
1. Prior to fabrication, field measure actual existing conditions to ensure proper fit.
2. Material shall be selected so that the finished installation shall provide an attractive and harmonious appearance. All exterior casework surfaces exposed to view after installation, and cabinet interior surfaces exposed to view when doors and drawers are in the open position, shall be select white maple. Solid woods and veneers exposed to view after completion of installation shall be of color and graining in conformance with the normally accepted standards required of the scientific laboratory equipment industry. All plywood shall be hardwood plywood certified by the manufacturer to be produced with No Added Formaldehyde (NAF). All woods shall be obtained from forests certified by an FSC accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Chain-of-custody documentation shall be provided in accordance with FSC's standards. Manufacturer shall provide certification and include statement indicating cost for each certified wood product. Softwoods such as Fir or Pine are not permitted.
3. Veneers exposed to view after completion of installation shall be of color and graining in conformance with the normally accepted standards required of the Scientific Laboratory Equipment Industry.

2.4 COMPONENTS

A. Epoxy Sinks:
1. Material: Epoxy Resin.
2. Construction: Taper side of sink. Inside corners radiused. Pitch bottom of sink to drain.
3. Size: See drawings.
4. Epoxy Sink Supports: Steel channels attached to sink cabinet ends and screw type adjustable rods to insure tight fit to underside of table with a water-proof compound.
5. Support Struts: Support struts shall consist of two 16 gauge channel uprights fastened top and bottom by two adjustable "U" shaped spreaders, each 12 gauge, 1-1/2" x length required. Struts shall be furnished to support drain troughs, and to support work top at plumbing space under fume hood superstructures or other heavy loads. They shall be fabricated so as to accept industry standard, pipe and conduit hangers.
6. Seal around drain with silicone sealant as recommended by epoxy sink manufacturer, and as specified in Division 07. Plumbers putty is not acceptable.

B. Cup Sinks:

a. Material: Black Epoxy Resin.
b. Size: 9 by 3 inches nominal.

C. Stainless Steel Sinks:
1. Sinks integral with stainless steel countertops: Weld-in with seams ground smooth and polished to match countertop finish.
a. Fabricate stock-sized sinks from deep drawn single sheets
b. Fabricate non-stock sized sinks having joints continuous heliarc welded, ground and polished smooth joints
c. Use stainless steel to fabricate integral sink of same type as adjacent stainless steel countertop
d. Interior coved corners with bottom pitched toward drain
2. Size: See drawings.
3. Free-standing Stainless Steel Sinks: See Division 22.
4. Sinks in non-laboratory areas: See Division 22.

D. Sink Strainer and Tailpieces:
1. Sink strainer and tailpieces:
a. Epoxy Sinks: Polypropylene. Coordinate tailpiece termination with service line connection requirements.
b. Stainless Steel Sink: See Division 22.

E. Epoxy Resin Countertops and Back Splashes:
1. Fabricate from epoxy resin unless otherwise noted in drawings.
2. Provide back splashes at rear of countertop and on end returns where indicated; notched as required.
3. Fabricate to install without field cutting or drilling. Drill holes in counter for laboratory service fixtures as scheduled in Section 123090.
4. Seal gap between back splash and wall with acrylic latex sealant specified in Division 07.
5. Joint between segments of tops and back splashes:
a. Smooth, even, and level with no raised edges
b. Width: 1/8 inch maximum
c. Seal watertight with modified epoxy resin cement
6. Epoxy Resin countertops:
a. Cut to size of cabinet or knee space below, where indicated on drawing. Where no indication is made, countertops lengths shall be at Contractor's option with termination points at base cabinet or knee space edges.
b. Do not cut to be smaller than 24 inches wide.
c. Fabricate with drip grooves on underside of exposed edges.
d. Fabricate exposed edges of base sections of countertops with a 1/4 inch chamfer on front top edge, square bottom edge, and vertical corners; fabricate other countertop edges with square tops and bottoms.
e. Bond back splash to surface of countertop to form square joint.
f. Back splash to be 4 inches (high, unless otherwise noted on Drawings.

F. Stainless Steel Countertops:
1. Construct countertops with raised front rim, marine edge construction to match existing adjacent fabrications.
2. Integrally and slightly radius joint where rear curb meets horizontal surface with radius dimension to match existing adjacent fabrication.
3. Weld carbon steel channels to underside in at least three locations along length to prevent twisting, oil canning, and buckling of surface.
4. Apply one coat of sound deadening material to underside but not to visually exposed surfaces.
5. Fabricate tops as single units; longest lengths as practical.

6. Provide field joints to join existing tops and work of this Section with welded channels and angles with bolting arrangements to pull tops together forming hair-line seam. Weld, grind smooth, and polish seams and joints to match adjoining surfaces.
7. Develop maximum strength and rigidity in construction and design of each fabrication.
8. Fabricate each sectional unit ready for placement in casework and equipment assembly.
    a. Fabricate as complete integral rigid unit in itself.
    b. Screw fasteners: Do not use in fabrication of units.
    c. Reinforce with galvanized steel hat sections with cross braces spaced no greater than 30 inches apart.
    d. Turn splash up, height to match existing adjacent fabrication.
    e. Turn splash back, dimension to match existing adjacent fabrication.
    f. Weld turned-up and turned-back portions together.

G. Peg Boards:
1. Constructed of modified epoxy resin.
2. Thickness: 1 inch
3. Color: To match adjacent counter tops.
4. Polish front surface, back surface, and edges.
5. Fabricate with:
    a. 30 inch high removable round-tip polypropylene peg section. Omit bottom row as required to avoid conflict with faucets
    b. Stainless steel drip trough with 1/4 inch diameter outlet below peg area
    c. Flexible clear tubing between drip trough outlet and sink (cut as required)
6. Mechanically fasten drip trough to pegboard and continuously seal with sanitary silicone specified in Division 07 at top edge.
7. Provide stainless steel peg boards where indicated on the drawings.

H. Hardware and Trim:
1. Drawer and Door Pulls:
   Drawer and door pulls shall be satin finish stainless steel wire pulls, and shall be securely fastened to doors and drawers with vandal-proof screws. Two pulls shall be required on all drawers over 24 inches long. Drawer pulls shall be mounted horizontally. Door pulls shall be mounted vertically.
2. Drawer Suspension:
   Provide full-extension, heavy duty drawers suspension.
   Loading capacity of 150 lbs. minimum.
3. Drawer Stops:
   Provide on drawers to prevent inadvertent removal.
4. Hinges:
   Hinges shall be the five (5) knuckle institutional. Hinges shall be 2-1/2" long, one (1) pair for doors under 4 ft in height and 1-1/2 pair on doors over 4 ft in height. Hinges shall be mounted with flathead screws, so applied to door and cabinet to withstand a weight load of 150 lbs. minimum. All hinges shall be satin finish stainless steel.
5. Locks:
    a. Locks shall be a National Lock, pin tumbler with heavy duty interchangeable cylinder. Exposed lock noses shall be dull nickel (satin) plated and stamped with identifying numbers. Locks shall have capacity of at least 1000 primary key changes.
    b. Provide locks where noted on lab plans.
    c. Keying:
       Key locks individually; two keys per lock.
       Master key locks by lab suite; two keys per suite.
       Provide two grand master keys for locks
6. Roller Catches:

Roller catches shall be used on swinging doors. Catches shall have a spring-loaded polyethylene roller and provided with a steel strike plate. Double-doors, without looks shall have a catch on each door. Full height cases shall have latching devices located on the structurally fixed center shelf. The left hand door shall have a positive catch and the right hand door shall have the roller type catch.

7. Elbow Catches:
   Elbow catches and strike plates shall be used on left hand doors of double door cases and are to be cast aluminum with bronze finish.
8. Leg Shoes:
   Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Shoes shall be 2-1/2" high and a pliable, black vinyl material. Use of a leg shoe which does not conceal leveling device will not be acceptable.
9. Base Molding:
   Refer to Division 9.
10. Shelf Support Clips:
    Shelf support clips for wood casework shall be pin type for mounting on interior of cabinet work. Clips shall be corrosion resistant and shall retain shelves from accidental removal. Shelves shall be adjustable on 1-1/4" centers. Surface mounted metal support strips and clips subject to corrosion are not acceptable.
11. Fasteners and Anchors:
    Size and type to securely fasten and anchor items to substrates and supporting structure.
12. Dowels:
    Dowels used to join frames and panels shall be fluted hardwood not less than 3/8” in diameter.
13. Label Holders:
    Label holders, where shown or called for, shall be aluminum brad-attached type with satin finish and designed for 2-1/2” x 1-1/8” cards, unless otherwise specified.
14. Number Plates:
    Number plates, where shown or called for, shall be aluminum brad-attached type with satin finish and indented black lettering.

I. Accessories:
   1. Gas Cylinder Supports :
      Aluminum cylinder supports to hold 4-1/2" to 14" diameter cylinders upright and ready to use, with safety strap and chain. Provide with safety reminder on both sides of buckle, and spring catch buckle. Attach to wall or bench, as indicated on drawings.

2.5 FINISH AND PERFORMANCE REQUIREMENTS

A. Environmental Standards:
   1. The finish must be low VOC and reclaimable with enclosed spray and/or roll coat application; thus providing an environmentally responsible product.

B. Wood Finish and Performance Requirements:
   1. Wood Surface Preparation:
      Prior to application of wood finish, all cabinet component surfaces shall be sanded smooth to remove loose fibers, scratch marks, and abrasions, with all dust thoroughly removed.
   2. Wood Finish Application:
      Cabinet components shall be finished using a state of the art flat-line system. The finish shall be applied under controlled conditions prior to casework assembly and attachment of hardware. This will provide maximum coverage and protection to the assembled product. The finish shall be fully UV cured to ensure proper performance.
   3. Exterior and Interior Wood Casework Finish: Interior and exterior surfaces shall receive two applications of chemical resistant, UV cured, epoxy top coat. The

finishing process described in this section shall result in a highly chemical resistant finish that is equally suitable for an AWI premium finish application. The first application shall be cured, sanded, and cleaned. The final top coat shall then be applied and fully cured. All cabinets shall be stained and additionally sealed with two applications of chemical-resistant epoxy top coat. The fully reclaimable low VOC water-borne stain shall be uniformly applied by a series of automated spray applicators. The stained components shall then travel through a series of heated chambers to incrementally achieve a temperature of 140 degrees F to dry the stain material. The first of two low VOC epoxy top coats shall be applied, cured, sanded, and cleaned. The final top coat will then be applied and UV cured, providing a semi-gloss sheen. The completed product shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS and SEFA

C. Steel Finish:

1. After cold rolled steel component parts have been completely fabricated and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.
2. After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.
3. The completed finish system in standard colors shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS and SEFA.

D. Performance Test Results (Chemical Spot Tests):

1. Testing Procedure:
   Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.
2. Test Evaluation:
   Evaluation shall be based on the following rating system.
   Level 0 - No detectable change.
   Level 1 - Slight change in color or gloss.
   Level 2 - Slight surface etching or severe staining.
   Level 3 - Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.
   After testing, panel shall show no more than three (3) Level 3 conditions.
3. Test Reagents :

Evaluation shall be based on the following rating system.

Test No.	Chemical Reagent	Test Method
1.	Acetate, Amyl	Cotton ball & bottle
2.	Acetate, Ethyl	Cotton ball & bottle
3.	Acetic Acid, 98%	Watch glass
4.	Acetone	Cotton ball & bottle
5.	Acid Dichromate, 5%	Watch glass
6.	Alcohol, Butyl	Cotton ball & bottle
7.	Alcohol, Ethyl	Cotton ball & bottle
8.	Alcohol, Methyl	Cotton ball & bottle
9.	Ammonium Hydroxide, 28%	Watch glass
10.	Benzene	Cotton ball & bottle
11.	Carbon Tetrachloride	Cotton ball & bottle
12.	Chloroform	Cotton ball & bottle
13.	Chromic Acid, 60%	Watch glass
14.	Cresol	Cotton ball & bottle
15.	Dichlor Acetic Acid	Cotton ball & bottle
16.	Dimethylformanide	Cotton ball & bottle
17.	Dioxane	Cotton ball & bottle
18.	Ethyl Ether	Cotton ball & bottle
19.	Formaldehyde, 37%	Cotton ball & bottle
20.	Formic Acid, 90%	Watch glass
21.	Furfural	Cotton ball & bottle
22.	Gasoline	Cotton ball & bottle
23.	Hydrochloric Acid, 37%	Watch glass
24.	Hydrofluoric Acid, 48%	Watch glass
25.	Hydrogen Peroxide, 3%	Watch glass
26.	Iodine, Tincture of	Watch glass
27.	Methyl Ethyl Ketone	Cotton ball & bottle
28.	Methylene Cloride	Cotton ball & bottle
29.	Mono Chlorobenzene	Cotton ball & bottle
30.	Naphthalene	Cotton ball & bottle
31.	Nitric Acid, 20%	Watch glass
32.	Nitric Acid, 30%	Watch glass
33.	Nitric Acid, 70%	Watch glass
34.	Phenol, 90%	Cotton ball & bottle
35.	Phosphoric Acid, 85%	Watch glass
36.	Silver Nitrate, Saturated	Watch glass
37.	Sodium Hydroxide, 10%	Watch glass
38.	Sodium Hydroxide, 20%	Watch glass
39.	Sodium Hydroxide, 40%	Watch glass
40.	Sodium Hydroxide, Flake	Watch glass
41.	Sodium Sulfide, Saturated	Watch glass
42.	Sulfuric Acid, 33%	Watch glass
43.	Sulfuric Acid, 77%	Watch glass
44.	Sulfuric Acid, 96%	Watch glass
45.	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46.	Toluene	Cotton ball & bottle
47.	Trichloroethylene	Cotton ball & bottle
48.	Xylene	Cotton ball & bottle
49.	Zinc Chloride, Saturated	Watch glass

* Where concentrations are indicated, percentages are by weight.

E. Performance Test Results (Heat Resistance):

1. Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate

not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.

F. Performance Test Results (Impact Resistance):
1. A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of a 3/4" thick plywood panel supported underneath by a solid surface and onto the finished surface of steel panel supported underneath by a solid surface.. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.

G. Performance Test Results (Moisture Resistance) (Plywood only):
1. A cellulose sponge (2" x 3" x 1") shall be soaked with water and placed on the finished surface for a period of 100 hours. The sponge shall be maintained in a wet condition throughout the entire test period. At the end of the test period, the surface shall be dried and no visible effect shall be shown on the finish.

H. Performance Test Results (Bending Test) (Steel only):
1. An 18 gauge steel strip, finished as specified, when bent 180^{o} over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.

I. Performance Test Results (Adhesion) (Steel only):
1. Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197-68, "Standard Method of Test for Adhesion of Organic Coatings".

J. Performance Test Results (Hardness) (Steel only):
1. The test sample shall have a hardness of 4-H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8-H is the hardest, and next in order of diminishing hardness are 7-H, 6-H, 5-H, 4-H, 3-H, 2-H, F, HB, B (soft), 2-B, 3-B, 4-B, 5-B (which is the softest).
2. The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel-like manner until one is found that will cut or scratch the film. The pencil used before that one-that is, the hardest pencil that will not rupture the film-is then used to express or designate the hardness.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with specifications.

3.2 INSTALLATION

A. Coordinate the work of the Section with the schedule and other requirements of other work being performed in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

B. Install in accordance with manufacturer's printed instructions and approved shop drawings.

C. Install items plumb, level, square, and free from warp and twist and securely anchor to building structure. Shim as required using concealed shims.

D. Screw continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16" tolerance.

E. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8" between top units.

F. Maintain dimensional tolerances and alignment with surrounding construction and adjacent surfaces.

G. Install miscellaneous filler panels and scribes for a continuous tight-fitting assembly without gaps and spaces between cabinets, counters, service chase, and adjoining surfaces.

H. Seal backsplashes at wall surfaces.

I. Interface With Other Work. Install items in a sequence to not delay:
   1. Adjoining construction
   2. Connections of casework and hoods to mechanical and electrical services.

3.3 ADJUSTING

A. Adjust parts for smooth, uniform operation.

B. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation

3.4 CLEANING

A. Comply with manufacturer cleaning instructions.

B. Clean shop finished casework; touch up as required.

C. Clean worksurfaces and leave them free of all grease and streaks.

D. Do not use materials and methods which may damage finish and surrounding construction.

3.5 PROTECTION

A. Protect finished work.

B. Advise contractor of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by other trades.

C. Post casework completion notices to alert other trades to the potential damage to completed work as required.

END OF SECTION 123400

SECTION 123450 – METAL LABORATORY CASEWORK AND FUME HOODS

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, Specification Section 123400 - Laboratory Casework-General Requirements, and Drawings apply to work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessory, necessary to furnish, deliver and install:
   1. Restricted bypass design chemical fume hoods, complete with fixtures, supports, lighting fixtures, cup sinks, etc.
   2. Restricted bypass design, ADA compliant chemical fume hoods, complete with fixtures, supports, lighting fixtures, cup sinks, etc.
   3. Restricted bypass design, walk-in, chemical fume hoods, complete with fixtures, supports, lighting fixtures, cup sinks, etc.
   4. Biosafety Cabinets
   5. Local Exhaust (Snorkels)
   6. Special Purpose Cabinets for Use under Fume Hoods
   7. Full Height Flammable and Acid Storage Cabinets
   8. Ceiling Service Panels
   9. Stainless Casework including:
      a. Floor Mounted Metal Base Cabinets
      b. Wall Mounted Metal Shelves
      c. Miscellaneous fillers and panels required for a finished installation

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. For general requirements, applicable to this and all other Casework Specification Sections including, but not limited to definitions, system description, submittals, quality assurance, mock-up, testing, field measurements, pre-installation conference, delivery, storage and handling, project conditions, and sequencing requirements, refer to Specification Section 123400 - Laboratory Casework-General Requirements.

E. Products Installed But Not Specified Under This Section:
   1. Section 123090 - Laboratory Service Fixtures: Supply of service fixtures for fume hoods for placement under this Section

F. Fume Hood Test Mock-Up
   1. General: Comply with provisions of Division 01.
   2. Fume Hood Test Mock-Up:
   3. Construct an operating prototype of the type of hood to be supplied for Project and demonstrate its ability to comply with fume hood performance requirements.
   4. Test Method: ANSI/ASHRAE Test 110-1995.
   5. Perform test under controlled conditions in manufacturer's test facility.
   6. Perform engineering and physical modifications on prototype to comply with performance requirements.
   7. Manufacturer retains ownership of prototype.
   8. Manufacturer bears costs of test mock-up and modifications to achieve performance

criteria.

9. Performance requirement: Meet or exceed the recommendations of the American Conference of Governmental Industrial Hygienists as defined in the most recent edition of "Industrial Ventilation. A Manual of Recommended Practice."
10. The fume hood, with vertical rising sash, shall provide adequate containment (meet ASHRAE standard) when combined with a VAV system set point of 80 fpm at full open and 100 fpm when the sash is set at 18" (normal operating height).

G. Acceptance:
1. Make adjustments necessary to meet minimum performance testing criteria and obtain acceptance from Architect. Do not proceed with shop fabrication or Project installation until mock-up has been tested, and accepted by Architect.
2. Accepted mock-up establishes minimum performance standards and quality for workmanship and materials for Project.

1.2 OPERATION AND MAINTENANCE DATA

A. Submit manufacturer's printed, operation and maintenance data.

B. Prior to final acceptance, affix one copy of each manual described in Demonstration Article to an unobscured exterior side panel of each hood.

C. Prior to final acceptance, submit certification that hazardous material cabinets have been electrically grounded as specified.

PART 2 PRODUCTS

2.1 GENERAL

A. For general requirements, applicable to this and all other Casework Specification Sections including, but not limited to, manufacturers, materials, components, and finish and performance requirements, refer to Specification Section 123400 - Laboratory Casework-General Requirements.

2.2 MANUFACTURERS

A. Acceptable Manufacturers:
1. Metal casework, chemical fume hoods, ADA compliant chemical fume hoods, walk-in chemical fume hoods, and miscellaneous fillers and panels required for a finished installation:
a. Kewaunee Scientific Corporation, Statesville, NC
b. ALC-Collegedale, Austin, TX
c. Jamestown Metal Products, Inc., Jamestown, NY

2.3 COMPONENTS

A. Services for Hoods:
Hoods shall be pre-piped and pre-wired at the factory. Plumbing and electrical services shall be as follows:
1. Plumbing services shall consist of front loaded remote control valves as selected located within the end panels, controlled by extension rods projecting through the control panels of the hood, with color coded handles. Interior fitting for gases and water shall be as specified in section 123090. All plumbing fittings shall be factory installed and piped between the valve and the outlet. If fittings are mounted in both

ends, there shall be two connection points. Piping shall be routed to the top of the hood. Location of plumbing services at ADA hoods shall comply with ADAAG requirements.

2. Pre-Wired hoods shall be wired using flexible metallic conduit to a single junction box located at the top of the hood for a single point connection at the job site. Electrical services shall consist of two duplex receptacles and a light switch. The duplex receptacles shall be 20 Amp, 125 volt AC, and 3-wire polarized grounded. The receptacles shall be of specification grade, ground fault interrupter type, side wired only, to insure a positive connection. The light switch shall be 20 Amp, 125 volt AC, and 3-wire polarized grounded. Location of electrical services at ADA hoods shall comply with ADAAG requirements.

2.4 RESTRICTED BYPASS CHEMICAL FUME HOODS

A. Standard for Quality and Design:
   1. Restricted Bypass Chemical Fume Hood - General Purpose Bench Type (Supreme Air by Kewaunee)

B. Description:
   1. Fume hoods shall be of complete airfoil design to insure maximum operating efficiency. Foil sections at the front fasciae of the hood shall minimize eddying of air currents at the hood face and the rear baffle system shall minimize turbulence in the upper portion of the hood interior.
   2. Restricted bypass fume hoods shall be designed for operation on variable air volume (VAV) exhaust systems when used with a fume hood face velocity controller. The air bypass shall be sized to provide an appropriate minimum exhaust volume so that when the sash is closed there will be sufficient exhaust air through the hood to dilute and prevent the escape of contaminants.
   3. Frame: A free-standing rigid frame structure of steel angle shall be provided to support exterior panels and interior liner and baffle panels. To allow for maintenance and replacements, the interior liner panels shall be removable without disassembly of the frame structure and outer steel panels. Likewise, the exterior steel panels shall be removable without disassembly of the frame structure and inner liner panels.
   4. Walls:
      a. Double wall ends, not more than 5" wide, shall be provided to maximize interior working area. The area between the double wall ends shall be closed to house the remote control valves. The front vertical fascia section shall have a full 135° 1" radius at the front leading edge to provide a streamlined section and insure smooth even flow of air into the hood. The vertical fascias shall contain the required service controls, electrical switches and receptacles. Side posts cannot exceed 4 inches in width. The hood interior end panels and sash track shall be flush with the fascia to prevent eddy currents and back flow of air.
      b. The hood exteriors shall be fabricated of cold rolled steel, phosphate coated with a baked chemical resistant, synthetic resin finish. Rear panel if rear side of hood is exposed to view; shall be finished to match material and color of remainder of hood's outer wall shell.
      c. Interior liner panels shall be 1/4" thick fiberglass reinforced polyester sheet. Interior liner panels shall be fastened using stainless steel screws with plastic covered heads.
      d. Access panels on both inside and outside of hood wall shall be provided. The interior end liner panels shall be furnished with an opening that provides access to the service piping and valves to facilitate installation and maintenance. The openings shall be covered with a removable panel with rounded corners. Panels which require tools to remove are not acceptable. The panel shall provide an overlapping seal on all edges.

5. Airfoil: A streamlined airfoil shall be installed at the bottom of the hood opening on bench hoods. This foil shall provide a nominal 1" open space between the foil and the top front edge of the worksurface to direct an air stream across the work surface to prevent back flow of air. The airfoil shall extend back under the sash, so that the sash does not close the 1" opening. The foil shall be removable to allow large equipment to be moved into the hood. The foil shall be of 12-gauge steel to resist denting and flexing.
6. Countertop: Construct countertops of 1 inch thick epoxy resin, with dished design to contain spillage with a 6 inch wide safety ledge across the front edge. Where countertops are penetrated by vent piping from fume hood base cabinet, piping shall be located behind the adjustable baffle and sealed tight all around at countertop with waterproof chemical-resistant sealant. A cup drain flush with the recessed worksurface shall be provided. The worksurface and cup sink shall be black. Continuous corrosion-resistant air-tight seam between hood lining and countertop shall be provided.
7. Fume Hood Cup Sinks
    a. Material: Stainless Steel
    b. Size: 3 by 6 inches nominal
8. Lighting
    a. Two tube T8 fluorescent light fixtures to generate 1075 lx (100 foot candles) of illumination inside hood.
    b. The light fixtures shall be isolated from the hood interior by a 1/4" thick tempered glass panel sealed from the hood cavity.
    c. Fixture shall be UL labeled.
    d. Re-lamping shall be performed from outside of hood front and shall not require removal of hood top-to-ceiling closure panel.
9. Baffles
    a. A baffle with three fixed horizontal slots shall be provided to aid in distributing the flow of air into and through the hood. The baffle shall be spaced out 2-1/4" from the back liner. The baffle shall be removable for cleaning.
    b. Externally adjustable baffle slots, top, and bottom shall be provided. A single point baffle adjustment shall be provided that will allow adjustment of the upper and lower slots. This single baffle adjustment shall allow the operator to make adjustments without placing their hand further than six inches into the hood.
10. Duct Collar
    a. 4 inches high and straight
    b. Outside Diameter: 10 to 12 inches
    c. Fabricated from UNS S31603 stainless steel
    d. Provide stainless steel transition if standard exhaust collar does not meet this requirement
11. Vertical Rising Sash: A vertical rising sash of 1/4" laminated safety float glass shall be provided. The sash shall have a neutral colored polyvinyl chloride horizontal member at the top and a full length metal handle at the bottom. The sash shall be counterbalanced with a single weight to prevent tilting and binding during operation. The sash track shall be a neutral colored polyvinyl chloride set flush with the interior liner panels to minimize turbulence. Bench hoods shall have one sash in a single slotted sash track.
12. Sash height limiting hardware
    a. Provide each fume hood with integral sash height hardware which prevents raising vertical sash above a set point
    b. Set points to be at full closure and 18 inches
13. Overall depth of hood: 36 inches.
14. Fan Operation Control: Shall be provided under Division 23 Mechanical.
15. Safety Monitor/Alarm System: See Division 23.

16. Closure panels:
    a. Provide fume hood closure panels from top of each fume hood to the underside of the finished ceiling.
    b. Match closure panels to fume hood's exterior color and finish.

2.5 RESTRICTED BYPASS CHEMICAL FUME HOODS - ADA

A. Standard for Quality and Design:
    1. Restricted Bypass Chemical Fume Hood - ADA compliant - General Purpose Bench Type (Supreme Air by Kewaunee)

B. Description:
    1. General construction for the ADA compliant Restricted Bypass Chemical Fume Hoods shall be the same as for the Restricted Bypass Chemical Fume Hoods, except as follows:
        a. ADA compliant restricted bypass fume hoods shall be designed to meet guidelines of the Americans with Disabilities Act (ADA).
        b. It shall be complete with Sash Stop, mounted at 21" above the lower deflector to keep the sash from rising above the operators reach.
        c. Fixtures and service fittings shall be moved down to within reach of wheelchair bound operator.
        d. It shall be provided with radiused corner posts and airfoils for smooth air movement to assure high level of comfort, safety and efficiency.
        e. ADA guidelines require a space of 30" wide by 30" high by 25" deep for a wheelchair to roll beneath a fume hood.

2.6 RESTRICTED BYPASS WALK-IN CHEMICAL FUME HOODS:

A. Standard for Quality and Design:
    1. Restricted Bypass Walk-In Chemical Fume Hood (Supreme Air by Kewaunee)

B. Description:
    1. General construction for Walk-in Hoods shall be the same as for restricted by-pass general purpose bench type chemical fume hoods except walk-in hoods shall be floor mounted design to handle large laboratory equipment with roll-in accessibility.

2.7 FUME HOOD FINISH:

A. After the component parts have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.

B. After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.

C. The completed finish in standard colors shall meet the performance test requirements specified under Steel Paint Finish Performance Test Results.

2.8 BIOSAFETY CABINETS

A. Acceptable Manufacturers:
   1. NuAire, Plymouth, MN (Model LabGard NU-440)
   2. The Baker Company, Sanford, Maine
   3. Labconco Corporation, Kansas City, MO

B. Biosafety Cabinets Tests
   1. Each unit, before shipping, shall have a complete physical test to assure cabinet meets Class II requirements.
   2. Manufacturer shall provide a certified copy of the personnel, product and cross-contamination (biological) tests, equivalent to or more demanding than as specified in NSF International Standard #49, performed on the unit selected, one unit from each production run from of cabinets for this project. Tests may be witnessed by a representative of the purchaser

C. Description:
   1. Four-foot or six foot, Class II Type A2, Biological Safety Cabinet, non-ducted, 100 percent recirculated, designed for biological work of low to moderate risk biological agents.
   2. The unit shall comply with NSF/ANSI classification #49, 2002, Class II Type A2.
   3. Interior Dimensions Inches:
      a. Width (W) 46-3/8 IN (Nominal 4 FT BSC) , or (W) 70-3/8 IN (Nominal 6 FT BSC)
      b. Depth (D) 23-1/2 IN
      c. Height (H) 28-1/2 IN
   4. The cabinet shall provide airflows & biological safety performance as specified:
      a. The cabinet shall provide biological containment protection for both operator and product proven by an actual test.
      b. The cabinet shall be constructed from 16GA, Type 304 stainless steel forming an all welded, monolithic, sealed structure.
      c. The cabinet shall be easily fumigated employing an established procedure such as that recommended by NSF.
      d. Supply HEPA filter shall be of full cabinet workzone width and depth; work zone below supply HEPA shall be of fixed cross-sectional area (sloping back wall or viewing window is unacceptable).
      e. Supply HEPA filter shall be protected by a perforated metal diffuser covering the entire top of the work zone.
      f. Air Velocity from the supply filter shall average 65 to 75 FPM (.32 to .38 m/s) with no single point outside the 20 percent of average range measured in a horizontal plane defined by bottom edge of window.
      g. Work access opening shall be 10 IN high. Average inflow velocity shall nominally be 105 LFPM (.53 m/s).
   5. The cabinet shall be ergonomically designed for maximum user comfort and adjustability to meet the requirements of the American Disabilities Act (ADA). Cabinet shall be provided with an adjustable, motorized, base stand which shall allow for the work surface to be at 30 to 36 inches above the finished floor.
   6. The cabinet shall have all positive pressure plenums surrounded by a vacuum relative to the room.
   7. Electrical power shall be supplied with a 12-foot, 3-wire cord with molded plug. Electrical supply shall be 115 VAC, 60 Hz.
   8. The cabinet shall have two internal electrical circuits; one for blower/lights and one for the duplex outlets.
   9. The cabinet shall be listed by Underwriters Laboratories.
   10. The cabinet shall contain a control system which is a self contained electronic module that will perform the following functions:

a. Control blower motor via solid state triac.
b. Monitor, display and control downflow via dual thermister airflow probe.
c. Disable audible alarm switch with ring back function.
d. Clock display (24 hours) and timer function.
e. Control lights via solid state switch.
f. Control outlets via solid state switch.
g. Complete diagnostic functions.
h. Monitor and display exhaust flow (inflow via dual thermister airflow probe.
i. Alarm setpoints high/low for error conditions (downflow and exhaust flow).

11. Balancing of cabinet workzone downflow (recycling flow) to exhaust flow shall be accomplished with an internal exhaust flow damper, externally adjustable. Damper access plug shall be under a vacuum relative to the room.
12. The cabinet shall be easily transportable through a standard 36 IN wide door without disassembly.
13. Sound level shall be no more than 67 dbA measured 15 IN above the work tray and 12 IN in front of viewing window.
14. Fluorescent lighting shall be externally mounted and provide 90 to 120 foot-candles on work surface. The ballast to be electronic containing thermal protection with automatic reset.
15. Cabinet shall be provided with two GFI duplex outlets with drip proof covers on back wall. See drawings for other required services.
16. Cabinet shall be a freestanding console model.
17. Cabinet workzone shall be all 16 GA. stainless steel and reinforced with stainless steel U channels to minimize vibration.
18. A 3/8 IN ball valve shall be provided in the drain trough beneath the work tray.
19. Cabinet shall have the capability of incorporating a permanent positive pressure plenum with quick release supply filter removal.
20. Motor/blower shall be positioned so as to create an even filter loading, thereby prolonging the life of the supply HEPA filter, and shall deliver over 80 percent the initial HEPA filter static pressure with no more than a 10 percent decrease of CFM.
21. Cabinet shall be capable of front filter removal without disassembly of the control panel and sliding window tracks/hardware.
22. The following equipment shall also be provided:
    a. Ultraviolet Light.
    b. Ground Fault Interrupter for Electrical System.
    c. Alarm Systems.
    d. Metal Framed HEPA Filters.
    e. HEPA Filters 99.999% @ 0.3 Micron.
    f. Stainless Steel Armrest.

2.9 LOCAL EXHAUST (SNORKELS)

A. Acceptable Manufacturers:
1. Nederman, Inc., Wetland, MI (Model #FX75 with metal hood)
2. Classic Modular Systems, Inc., Houston, TX
3. Movex, Inc., Bath, PA

B. Description:
1. Ceiling Mounted Local Exhaust (Snorkels) shall be designed for use with movable equipment.
2. The arms shall consist of three pipes with a 3 inch diameter, manufactured from Anodized Aluminum.
3. Maximum reach: 5 ft.
4. The arms shall be flexible in all directions and stay in position when adjusted. Vertically and horizontally jointed, the arms shall be able to rotate 360º by its swivel function.

5. The arms shall be resistant to different solvents and certain chemicals, and it shall be easy to dismantle for internal cleaning.
6. They shall be provided with a metallic hood.

2.10 SPECIAL PURPOSE CABINETS FOR USE UNDER FUME HOODS:

A. Acid Storage Cabinets:
Where indicated acid storage cabinets shall use the same gauges of steel and construction features as other base cabinets. In addition, they shall have a one-piece liner insert made of linear low-density polyethylene. The liner insert shall form a one-inch pan at the bottom to retain spillage. Each door will have a set of louvers at the top and bottom. The door shall be lined with a polyethylene sheet. Each cabinet shall be vented into the fume hood with a 1-1/2" vent pipe, providing a positive airflow directly into the fume hood exhaust system.

B. Solvent Storage Cabinets:
Solvent storage cabinets shall be UL labeled and specifically designed for the storage for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by UL, UFC, OSHA, and NFPA No. 30 - 2003. The bottoms, top, sides and doors shall be fabricated of 18 gauge steel and shall be all double panel construction with a 1-1/2" air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure. The doors shall swing on full-length stainless steel piano hinges and shall be fully insulated. The right hand door shall be equipped with a three point latching device and the left-hand door shall have a full height astragal. The doors shall be self-closing and synchronized so that both doors will always fully close. The right hand door shall be equipped with a three-point latching system that automatically engages when the doors close. Each door shall be equipped with a fusible-link hold-open feature that will ensure the door closes should the temperature outside the cabinet exceed 165 degrees Fahrenheit. Units 24" long shall have only one door, self-closing, and equipped with a three-point latching system and hold-open feature. A 2" deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills. A full-depth adjustable shelf shall also be provided. Two diametrically opposed vents with spark screens shall be provided in the back of the cabinet as well as a grounding screw. The cabinet shall have an interior finish the same as the exterior and shall be labeled: "FLAMMABLE - KEEP FIRE AWAY".

2.11 FULL HEIGHT FLAMMABLE AND ACID STORAGE CABINETS:

A. Acceptable Manufacturers:
1. Justrite, Des Plaines, IL
2. Secureall Safety Storage Equipment, Laporte, IN
3. SciMatCo, Scientific Materials Company, Batavia, IL

B. Solvent Storage Cabinets:
1. Solvent storage cabinets shall be UL labeled and specifically designed for the storage for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by UL, UFC, OSHA, and NFPA No. 30 - 2003.
2. The bottoms, top, sides and doors shall be fabricated of 18 gauge steel and shall be all double panel construction with a 1-1/2" air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure. The doors shall swing on full-length stainless steel piano hinges and shall be fully insulated. The right hand door shall be equipped with a three point latching device and the left-hand door shall have a full height astragal. The doors shall be self-closing and synchronized so that both doors will always fully close. The right hand door shall be equipped with a three-point latching system that automatically engages when the doors close. Each door shall be equipped with a fusible-link hold-open feature that will ensure the door closes should the temperature outside the cabinet exceed 165 degrees Fahrenheit. Units 24" long shall have only one door, self-closing, and equipped with a three-point locking system

and hold-open feature.

3. A 2" deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills.
4. A full-depth adjustable shelf shall also be provided. The shelves shall have built-in troughs to catch incidental drips and easy adjust on 2 ¼" centers for versatile storage. Heavy-gauge galvanized steel shelves, ribbed for extra strength to support 350 lb., weight capacity shall be provided.
5. Two diametrically opposed vents with spark screens shall be provided in the back of the cabinet as well as a grounding screw.
6. The cabinet shall have an interior finish the same as the exterior and shall be labeled: "FLAMMABLE - KEEP FIRE AWAY".

C. Acid Storage Cabinets:

1. Acid storage cabinets shall have the same quality features specified for flammable cabinets, including double wall, 18-fauge, welded steel construction, adjustable selves, three-point self latching doors and level feet.
2. A one-piece liner insert made of linear low-density polyethylene shall be provided. The liner insert shall form a two-inch pan at the bottom to retain spillage. The door shall be lined with a polyethylene sheet. Two diametrically opposed vents with spark screens shall be provided in the back of the cabinet as well as a grounding screw.

D. Combination Corrosive and Flammable Storage Cabinets:

1. Combination cabinets shall be constructed of 1" thick multi-ply, exterior grade plywood with chemical-resistant paint.
2. All cabinets shall be constructed to meet and exceed all applicable NFPA and OSHA standards.
3. Individual cabinets shall be designed for stacking.
4. Cabinets shall be easily identified by cabinet color and 10" hazard label.
5. All cabinets shall have a liquid-tight, 2" trough to contain accidental spills.
6. Flammables cabinets shall be provided with self-closing doors.

2.12 CEILING SERVICE PANELS

A. Ceiling service panels shall be designed to integrate into common ceiling grids providing a method of delivering plumbing, electrical and data service to the lab benches.

B. The panels shall fit in standard 2' x 2' and 2' x 4' ceiling grids.

C. Power components shall be UL listed and shall be pre-wired.

D. The panels shall accommodate the lab services indicated on the lab plans. They shall accept quick-connect valves, fittings and hoses as indicated as well as communication and data outlets and electrical service outlets.

E. Finish:

1. Powder coat finish.
2. Performance of painted surfaces shall meet the requirements specified in Section 123400 – Laboratory Casework-General Requirements.
3. Color to be selected by Architect from manufacturer standard colors.

2.13 STAINLESS STEEL CASEWORK

A. Construction:

1. All units shall be flush front construction with intersection of vertical and horizontal case members, such as end panels, top rails, bottoms and vertical posts in same plane

without overlap. Exterior corners shall be spot welded with heavy back up reinforcement at exterior corners. All face joints shall be welded and ground smooth to provide a continuous flat plane.

2. All units shall have a cleanable smooth interior. Bottom shall be the pan type with both sides and back formed up for easy cleaning. Bottoms with pans turned down must be caulked around inside perimeter. Fabricate concealed surfaces of inner and outer pans from same finish as exposed surfaces.
3. Unless otherwise indicated all casework units shall be fabricated of stainless steel.
4. Toe space member:
   a. Size: 4 inches high by 3 inches deep, unless otherwise noted on Drawings.
   b. Fabricate with channel-shaped flanges at bottoms, and flange at top for engagement with bottom rails forming interlocking joints.
5. Corner gusset plates:
   a. Provide in each corner of sectional units.
   b. Floor mounted casework shall be equipped with leveling devices easily adjustable from within units, to compensate for unevenness in floor.
   c. Fabricate leveling socket as integral part of gusset plate.
   d. Provide slot in each 1/2 inch leveling bolt for easy adjustment using screwdriver from above.
   e. Provide access to leveling bolt through holes in cabinet bottoms directly above leveling bolts.
   f. Provide access holes in cabinet bottoms with removable snap-on covers.
6. Doors:
   a. Fabricate of double wall sound deadened construction. Place sound-deadening mineral filler between inner and outer pans for quiet operation.
   b. Fabricate for fit with minimum clearance.
   c. Fabricate inner door pans to be held securely in place by concealed fasteners that are easily removable for cleaning in case of spillage.
   d. Where swinging doors are specified or shown, fabricate of double wall construction, glazed where specified.
7. Adjustable shelves in cabinets:
   a. Fabricate with adjustable supports at 1/2 inch centers.
   b. Support shelves on adjustable shelf clips, made of cadmium plated steel, engaging in slotted members so dust cannot accumulate at bottoms. Clips shall retain shelves to prevent accidental removal.
   c. Provide 2 inch high lip at back of rear portion of shelf to prevent shelf contents from falling.

B. Base Cabinets:
1. Construct base cabinets to achieve industry standard height of 31 inches or 37 inches with a 1 inch countertop without raising cabinet off floor beyond height required for normal leveling conditions (1 inch nominal).
2. Removable access panel:
   a. At cupboards and knee spaces.

C. Accessories:
1. Fasteners and Anchors: Size and type to securely fasten and anchor items to substrates and supporting structure.
2. Provide miscellaneous fillers and panels required for a finished installation.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. For General Installation Requirements, applicable to this and all other Casework Specification Sections including, but not limited to, examination, installation, adjusting,

cleaning, and protection general requirements, refer to Specification Section 123400 - Laboratory Casework-General Requirements.

3.2 ADDITIONAL INSTALLATION REQUIREMENTS

A. Fasten together assemblies to meet Performance Requirements specified above.

B. Floor Mounted Cabinets:
   1. Locate at designated positions.
   2. Level by means of adjustment device located in cabinet's bottom corners.

C. Countertops: Anchor to base cabinets.

D. Field Joints:
   1. Reinforce and weld in manner equivalent to shop welds and joints.

E. Wall Joints:
   1. Joints between equipment and walls up to 3/8 inches wide:
      a. Fill with sealant backing bond breaker rod and silicone sealant.
      b. Comply with requirements of Division 07.
      c. Apply sealant in one continuous pass, compressing surface slightly concave and forcing contact with both sides of joints.
   2. Joints between casework and walls larger than 3/8 inches wide:
      a. Seal with stainless steel closure or filler strip.
      b. Fit tightly and fasten securely with concealed clips.

F. Site Tolerances: Install wall-to-wall countertops with a maximum 1/4 inch gap.

END OF SECTION 123450

SECTION 123460 - WOOD LABORATORY CASEWORK

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, Specification Section 123400 – Laboratory Casework-General Requirements, and Drawings apply to work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessories, necessary to furnish, deliver and install:
   1. Wood Laboratory Casework:
      Open-leg Tables
      Wood Aprons
      Floor Mounted Base Cabinets
      Wall Hung Cabinets
      Full Height Cabinets
      Island Bench Structural Modules
      Adjustable Shelves
      Wall Mounted Shelving Systems
      ADA Workstations
      Mobile Instructor Workstations
      Miscellaneous fillers and panels required for a finished installation

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. For general requirements applicable to this and all other Casework Specification Sections including, but not limited to definitions, system description, submittals, quality assurance, mock-up, testing, field measurements, pre-installation conference, delivery, storage and handling, project conditions, and sequencing requirements, refer to Specification Section 123400 for Laboratory Casework - General Requirements.

E. Products Installed But Not Specified Under This Section:
   1. Section 123090 - Laboratory Service Fixtures: Supply of service fixtures for placement under this Section.

PART 2 PRODUCTS

2.1 GENERAL

A. For general requirements, applicable to this and all other Casework Specification Sections including, but not limited to, manufacturers, materials, components, and finish and performance requirements, refer to Specification Section 123400 - Laboratory Casework-General Requirements.

2.2 MANUFACTURERS

A. Casework Acceptable Manufacturers:
   1. Thermo Scientific ALC, Austin, TX (ALC GOLD Series)
   2. Kewaunee Scientific, Statesville, NC
   3. Mott Manufacturing, Maxwelton, WV

2.3 FABRICATION

A. General Requirements:
   1. Prior to fabrication, field measure actual existing conditions to ensure proper fit.
   2. Material shall be selected so that the finished installation shall provide an attractive and harmonious appearance. All exterior casework surfaces exposed to view after installation, and cabinet interior surfaces exposed to view when doors and drawers are in the open position, shall be select white maple. Solid woods and veneers exposed to view after completion of installation shall be of color and graining in conformance with the normally accepted standards required of the scientific laboratory equipment industry. All plywood shall be hardwood plywood certified by the manufacturer to be produced with No Added Formaldehyde (NAF). All woods shall be obtained from forests certified by an FSC accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Chain-of-custody documentation shall be provided in accordance with FSC's standards. Manufacturer shall provide certification and include statement indicating cost for each certified wood product. Softwoods such as Fir or Pine are not permitted.
   3. Veneers exposed to view after completion of installation shall be of color and graining in conformance with the normally accepted standards required of the Scientific Laboratory Equipment Industry.
   4. The cabinets shall be full overlay construction with 3/4" thick door and drawer fronts. The exposed face of doors and drawer heads shall be vertical matching grain, with all doors and drawer heads for each cabinet cut from a single sheet of select white maple veneer core plywood. The door and drawer heads shall occupy a plane extending 3/4" past the plane of the front of the cabinet body, shall be square edged, and shall overlay the face of the cabinet leaving minimal reveals. All cabinet end panels shall be finished for the purpose of future relocation.

B. Open-leg Tables:
   Legs shall be maple hardwood construction, 2-1/2" square with all corners radiused 1/4". Legs shall be secured to the apron frame by a heavy duty corner bolt and a 14-gauge metal corner brace. Corner braces shall be locked into apron rails by accurately located grooves and shall be securely fastened with screws. This construction shall guarantee equal tension on all wood and metal parts. Top edge shall be grooved for securing top fasteners. Leg stretchers, where required, shall be 1-5/16" x 2-1/2", utilizing a mortise and tenon joint with legs and secured with a 4" long through bolt.

C. Wood Aprons:
   All apron rails shall be 3/4" thick 5-ply maple veneer lumber core plywood.

D. Floor Mounted Base Cabinets:
   1. Panels and Rails:
      a. All cabinet end panels shall be 3/4" thick select white maple veneer core plywood with 1/8" thick select white maple facing on exposed vertical edges and bottom horizontal edge.
      b. Bottom panels and toe space rails shall be 3/4" thick select white maple veneer core plywood with 1/8" thick select white maple facing on exposed edges.
      c. Top panels shall be 1" thick select white maple veneer core plywood with 1/8" thick select white maple facing on exposed edge.
      d. End panels shall be multiple doweled, glued, and screwed to top panel, bottom panel and toe space rail.
      e. Cupboard base cabinet shelves shall be full-width adjustable, 3/4" thick select white maple veneer core plywood with 1/8" thick select white maple facing on exposed edge. Shelves shall be adjustable on 32mm centers utilizing shelf support clips.
      f. Sink cabinets shall be made without a top panel.
   2. Backs:

Cabinet backs shall be 1/4" thick hardboard, dadoed into end panels and securely fastened to cabinet bottom and top panels. Backs that are attached to end panels with cleats shall be unacceptable. Removable backs shall be provided at all cupboard base cabinets. Base Cabinets with drawers shall have full backs.

3. Intermediate Rails:
   Intermediate rails shall be 3-1/4" x 3/4" veneer core plywood with 1/8" thick select white maple facing on exposed edge. Rails shall be screwed to end panels. Intermediate rails shall be mounted at the front between the drawers and between all drawers and doors.
4. Drawers Bodies:
   Drawer bodies shall be 20 gauge, painted, cold rolled steel, made in a one-piece construction including the bottom, two sides, back and front. They shall be fully coved at interior bottom on all four sides for easy cleaning.
5. Drawer Heads:
   Drawer heads shall 3/4", select white maple plywood with 1/8" select white maple edging and shall be mounted to the front of the steel drawer bodies. Each drawer head under 30" wide shall have one pull mounted horizontally, drawer heads 30" and over shall have two pulls.
6. Doors:
   Doors shall be 3/4", select white maple, plywood with 1/8" select white maple edging, mounted on cabinet with 1 pair of offset hinges and shall be latched with a roller catch. Double doors shall have a roller catch on each door. Each door shall have one pull mounted vertically. Locks, when required on double doors, shall be mounted on the right-hand door and the left-hand door shall have a select white maple astragal.

E. Wall Hung Cabinets:
   1. All cabinet end panels shall be 3/4" thick select white maple veneer core plywood with 1/8" select white maple facing on front edges. Tops and bottoms shall be 1" thick select white maple veneer core plywood with 1/8" select white maple facing on exposed edges, multiple doweled into end panels, and secured with glue and countersunk screws. Shelves shall be full-width adjustable, 3/4" thick select white maple veneer core plywood with 1/8" thick select white maple facing on exposed edge. Shelves shall be adjustable on 32mm centers utilizing shelf support clips. The backs shall be 3/8" select white maple veneer core plywood.
   2. Doors:
      a. Sliding Plate Glass Doors:
         Solid glass doors shall be 1/4" thick float glass with polished edges. Doors shall be set in an aluminum bottom frame containing roller bearings and held in position with an aluminum guide at the top of the case.
      b. Swinging Doors:
         Cabinets shall be designed and integrally constructed for full enclosure to assure dust proofing of the cabinet interior.
         Doors shall either be solid hardwood core panel or glass framed, as indicated. Solid hardwood core doors shall be 3/4", select white maple plywood with 1/8" select white maple edging. Glass doors shall be 1/4" thick float glass with polished edges.
         Doors shall be hung on 1 pair of offset hinges and shall latch with a roller catch. Double doors without locks shall have a roller catch on each door. Double doors with locks shall have an elbow catch and select white maple astragal mounted to the left-hand door and the lock and a roller catch mounted on the right-hand door. Glass shall be set indo door solid maple frame and secured with a plastic retainer.

F. Full Height Cabinets:
   1. Cabinet:

a. Cabinets shall be designed and integrally constructed for full enclosure to assure dust proofing of the case interior.
b. All cabinet end panels shall be 3/4" thick select white maple plywood with 1/8" select white maple facing on exposed vertical edges and bottom horizontal edge. Tops shall be 1" thick select white maple plywood with 1/8" select white maple facing on exposed edge, multiple doweled into end panels, secured with glue and countersunk screws.
c. Shelves shall be full-width adjustable, 3/4" thick select white maple plywood with 1/8" thick select white maple facing on exposed edge. Adjustable shelves shall be adjustable on 32mm centers utilizing shelf support clips. To assure a completely rigid case, a fixed center shelf of 1" thick select white maple veneer core plywood with 1/8" select white maple facing on exposed edge, shall be multiple doweled into end panels, secured with glue and countersunk screws.
d. Cabinet bottoms shall be 3/4" thick select white maple plywood, multiple doweled and glued securely to end panels. All cabinets 22" in depth shall have a 3/4" x 3-3/4" select white maple plywood toe space rail to form a 4" high toe space. Cabinets 16" deep shall use a 1" x 4-1/2" select white maple plywood base rail mounted flush with the face of the cabinet. The backs in full height cabinets shall be 3/8" select white maple veneer core plywood. Cabinet interior shall be flush.

2. Doors:
a. Doors shall either be solid hardwood core panel, glass framed, screen framed or with marker board, as indicated.
b. Doors shall be 3/4", select white maple plywood with 1/8" select white maple edging. Each door shall have one pull mounted vertically, shall be hung on 1-1/2 pair of offset hinges, and shall latch with a roller catch. Double doors without locks shall have a roller catch on each door. Double doors with locks shall have an elbow catch and select white maple astragal mounted to the left-hand door and the lock and a roller catch mounted on the right-hand door.
c. Glass framed doors shall be 3/4" thick with 1" thick by 3-3/16" wide solid maple framing, mortised, tenoned, and glued. Glass shall be set into door frame and secured with a plastic retainer.
d. Screen framed doors shall be black aluminum wire mesh with protective finish to prevent corrosion.
e. Marker board doors shall be 3/4", select white maple plywood with 1/8" select white maple edging. A dry-erase magnetic white board shall be applied to the wood door.

G. Island Bench Structural Modules:
1. Island Structural Modules shall be made from cold-rolled steel with a corrosion and chemical resistant finish as specified in 123400.
2. Structure Modules shall provide support structure.
3. The structural modules shall be capable of supporting adjustable shelving on each side.
4. Single or double-slotted uprights shall have holes on 1 inch centers for adjustable shelves.

H. Adjustable Shelves:
1. Adjustable module shelving shall attach to the structural module upright, or to the wall mounted rails, with height adjustability on 1 inch increments.
2. Adjustable module shelves shall be supported by 11 gauge brackets, which shall mount to the single or double-slotted support module upright. Shelf brackets shall be mounted above or below the shelves as shown on drawings.
3. Outer and Inner shelves shall be 1" thick hardwood plywood with maple veneer on all exposed surfaces.

4. Top outer shelves shall fit flush with top ledge of panel or core. Top surface of pane or core shall act as inner shelf.
5. End lips shall be provided.
6. Inner shelves shall be added to back of outer shelves to fill the space between island uprights.

I. Wall Mounted Shelving System:
1. Wall Mounted Shelving Systems shall consist of Wood Shelves, with Heavy Duty Vertical Wall Standards, and Heavy Duty Adjustable Shelf Brackets. Fasten standards to concrete masonry walls or properly blocked steel studded walls with appropriate flat head screws.
2. Vertical Wall Standards shall allow adjustable bracket to be positioned along its full length for maximum use of space. A pair of vertical supports shall hold the shelves and their support brackets.
3. Adjustable shelf bracket shall have up-turned lip to prevent shelves from being pulled off bracket. It shall be formed from high-strength, cold-rolled steel. It shall include mounting hardware to secure bracket to vertical wall standards.

2.4 MOBILE ADA WORKSTATION

A. Kewaunee (Model #T05H3760-0 ADA Workstation)
1. Handicapped accessible, with four inch swivel casters, two of them equipped with brakes.
2. It shall be built of maple and plywood.
3. Complete with Epoxy Resin Countertop.
4. Size: 30” Deep by 60” Long by 30”-37” adjustable height on 1” increments.
5. Cabinet: Two drawer cabinet (Kewaunee Model # D81H1918-0)
6. Sink: 9” Diameter – Stainless Steel
7. 1 ½” I.P.S. Stainless Steel Sink Outlet
8. 6ft. Long 1” dia. Stainless Steel Braided Drainline Hose with Quick-Disconnect hose fittings.
9. Electric Fixtures: 120 VAC GFI Duplex Pedestal (Kewaunee Model # 0656-02)
10. 8 ft long extension cord
11. Fittings:
    a. Cold and Hot Water w/4” Wrist Blade Handles (Kewaunee Model # W-0340-0V).
    b. 4ft. long ½” dia Reinforced PVC Cold and Hot Water Service Hoses with Quick-Disconnect. Color coded per services.
    c. Single Outlet Service Fitting (Kewaunee Model # W-0260-00).
    d. 4ft. long 3/8” dia Reinforced PVC Gas/Air/Vac Service Hose with Quick-Disconnect Hose Fittings. Color coded per services.

2.5 MOBILE INSTRUCTOR WORKSTATION

A. Kewaunee (Model #T57W323060-XX Mobile Instructor Workstation)
1. Handicapped accessible, with four inch swivel casters, two of them equipped with brakes.
2. It shall be built of maple and plywood.
3. Complete with Epoxy Resin Countertop.
4. Size: 30” Deep by 60” Long by 34” High.
5. Storage Cabinets: As shown on lab drawings
6. Sink: 6” Diameter – Stainless Steel
7. Totally self-contained with its own services. It shall be furnished complete with cold water pump gooseneck, and one gallon carboys for water supply and waste.
8. Electric Fixtures: 120 VAC GFI Duplex Pedestal (Kewaunee Model # 0581-02)
9. 8 ft long extension cord and plug.

10. Provide complete with Rod Sockets, ½" dia. upright rods, 18" long and upright rod assembly.

2.6 ACCESSORIES

A. Fasteners and Anchors: Size and type to securely fasten and anchor items to substrates and supporting structure.

B. Provide miscellaneous fillers and panels required for a finished installation.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. For General Installation Requirements, applicable to this and all other Casework Specification Sections including, but not limited to, examination, installation, adjusting, cleaning, and protection requirements, refer to Specification Section 123400 for Laboratory Casework - General Requirements.

3.2 ADDITIONAL INSTALLATION REQUIREMENTS

A. Floor Mounted Base Cabinets:
   1. Locate at designated positions
   2. Level by means of adjustment device located in cabinet's bottom corners

B. Countertops: Anchor to base cabinets, unless noted otherwise.

C. Fasten together assemblies listed below with devices of adequate strength to support cabinet and shelves loaded 40 pound per square foot per shelf for enclosed wall cabinets or open adjustable shelves not inclusive of cabinet, shelf, and bracket weight.
   1. Wall cabinet to wall
   2. Wall mounted shelves to wall

D. Site Tolerances: Install wall-to-wall countertops with a maximum 1/4 inch gap.

END OF SECTION 123460

SECTION 123470 - POLYPROPYLENE LABORATORY CASEWORK

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, Specification Section 123400 – Laboratory Casework-General Requirements, and Drawings apply to work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessories, necessary to furnish, deliver and install:
   1. Polypropylene Laboratory Casework:
      Floor Mounted Base Cabinets (Swinging doors, drawers and open shelves)
      Wall Hung Cabinets
      Adjustable Shelves
      Miscellaneous fillers and panels required for a finished installation

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. For general requirements applicable to this and all other Casework Specification Sections including, but not limited to definitions, system description, submittals, quality assurance, mock-up, testing, field measurements, pre-installation conference, delivery, storage and handling, project conditions, and sequencing requirements, refer to Specification Section 123400 for Laboratory Casework - General Requirements.

E. Products Installed But Not Specified Under This Section:
   1. Section 123090 - Laboratory Service Fixtures: Supply of service fixtures for placement under this Section.

PART 2 PRODUCTS

2.1 GENERAL

A. For general requirements, applicable to this and all other Casework Specification Sections including, but not limited to, manufacturers, materials, components, and finish and performance requirements, refer to Specification Section 123400 - Laboratory Casework-General Requirements.

2.2 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Polypropylene casework and miscellaneous fillers and panels required for a finished installation, by NuAire, Plymouth, MN or approved equal.

2.3 CASEWORK FABRICATION

A. Prior to fabrication, field measure actual existing conditions to ensure proper fit.

B. Casework shall be of sealed and solid seamed welded polypropylene construction, including casework, countertops and accessories.

C. Polypropylene shall be a high corrosion resistant material that has high temperature and tensile strength. It shall possess excellent chemical resistance to organic solvents and degreasing agents as well as electrolytic attack. The properties of polypropylene shall be enhanced with anti-oxidizing agents and UV stabilizers to increase strength and improve thermal characteristics. Polypropylene shall be light weight, stain resistant and have a low moisture absorption rate.

D. All polypropylene casework shall be manufactured from ¼", 3/8" and ½" stress relieved, refrigerator white standard polypropylene.

E. Each casework unit shall be machined from a full length sheet of polypropylene, designed to be folded into an unbroken surface and seamless exterior (except one rear corner). All interior surfaces shall be completely seam welded and reinforced, where necessary, forming a completely rigid and self-supporting cabinet that can be used interchangeably in a group of casework or can be used as a stand-alone cabinet. When properly installed, the casework shall provide an easily cleaned, smooth and flush interior and a dust resistant installation.

F. All drawer and door pulls shall be constructed from polypropylene, which offer a comfortable hand grip, through-bolt attachment to the upper middle of drawer/door fronts, with polypropylene fasteners from the back face. Two pulls shall be provided on drawers wider than 24 inches.

G. All doors shall be solid one-piece construction and of overlapping design. Hinges shall be molded from refrigerator white polypropylene, with a minimum of three-knuckles rounded edge barrel. A minimum of two hinges shall be provided for doors under 36 inches. Each hinge shall be attached to the door and frame with two polypropylene screws on each side. Door catches shall consist of 20-mil polyethylene coated magnets that are imbedded into the door/frame at the top and bottom of each door. The catches shall provide a minimum pull of seven pounds. Where adjustable shelves are required in base cabinets or cupboards, the precision PVC adjustment clips shall allow you to adjust shelf positions on 1- ½" increments. Shelves that are placed over 5 feet above finished floor (AFF) shall have a ½ inch seismic restraining lip.

H. Drawer guides (on each side) shall provide quiet, smooth and precise operation with little or no side-to-side motion when withdrawing the drawer. The drawers shall be constructed from ½ inch polypropylene, through out, in the same "V" groove, fold-up fashion as the base cabinets, providing a seamless exterior. The drawer fronts shall be a separately welded piece. All drawers shall have integral draw stops to prevent inadvertent drawer removal and contact with the back of the cabinet, yet allow easy removal without the use of tools.

I. The standard method of leveling the base cabinets to the floor, shall utilize polypropylene shims. It should be recognized that ALL POPYPROPYLENE CONSTRUCTED PRODUCTS because of their flexible nature do not lend themselves to field adjustment procedures that permit door/drawer adjustments. Field adjustability is minimal, therefore proper leveling of casework at the time of installation is critical. Leveling devices in base cabinets shall be provided in each corner of the base cabinet. The leveling one inch thick threaded polypropylene rods shall be adjusted from within the cabinet's interior and provide for a one inch adjustment. The levelers shall be protected by a ½ inch lip with cover around the leveler to control spill leakage under the cabinet.

J. All base cabinets with doors shall be configured with a removable access panel in the rear for access to a plumbing utility chase. Panels shall be ¼ inch thick polypropylene mounted flush within the rear wall's ½ inch thick polypropylene. Polypropylene screws shall fasten the panel to the rear wall. All base cabinets with drawers shall be configured with a closed back panel to prevent items from falling into the chase behind. All base cabinets shall have a 4 inch high by 3 inch deep toe kick.

K. All base cabinets shall have a full length 3 inch gusset on both the front and rear top for fastening the countertop. Each base cabinet shall also have a ½ inch spill lip at the front floor to contain liquids.

L. Base cabinet (type B14) with pull-out shelf and full extension, heavy duty shelf suspension system loading capacity of 200 lbs. minimum.

M. All non-plastic internal surfaces and/or components shall be corrosion, flame, and moisture resistant. They shall not deteriorate when exposed to liquid or vapor phase decontaminants, such as formaldehyde, alcohol, iodophors, peracetic acid, halogenated phenols, and hypochorite solutions.

N. Fasteners and Anchors: Size and type to securely fasten and anchor items to substrates and supporting structure.

O. Provide miscellaneous fillers and panels required for a finished installation.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. For General Installation Requirements, applicable to this and all other Casework Specification Sections including, but not limited to, examination, installation, adjusting, cleaning, and protection requirements, refer to Specification Section 123400 for Laboratory Casework - General Requirements.

3.2 ADDITIONAL INSTALLATION REQUIREMENTS

A. Floor Mounted Base Cabinets:
   1. Locate at designated positions
   2. Level by means of adjustment device located in cabinet's bottom corners

B. Countertops: Anchor to base cabinets, unless noted otherwise.

C. Fasten together assemblies listed below with devices of adequate strength to support cabinet and shelves loaded 40 pound per square foot per shelf for enclosed wall cabinets or open adjustable shelves not inclusive of cabinet, shelf, and bracket weight.
   1. Wall cabinet to wall
   2. Wall mounted shelves to wall

D. Site Tolerances: Install wall-to-wall countertops with a maximum 1/4 inch gap.

END OF SECTION 123470

SECTION 123661 – SOLID SURFACE COUNTERTOPS AND WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-surface-material countertops and backsplashes.
2. Solid-surface-material convenience shelf.
3. Quartz-surface wall panels.

B. Related Sections:

1. Division 06 Section “Interior Architectural Woodwork” for solid surface countertops mounted to plastic laminate cabinets.
2. Division 22 Section "Plumbing Fixtures" for under-counter mounted sinks and plumbing fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For countertop and wall panel solid-surface materials.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Certificates for Credit MR 7: Chain-of-custody certificates indicating that wood products comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
3. Product Data for Credit IEQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports for Credit IEQ 4: For adhesives, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

D. Samples for Initial Selection: For each type of material exposed to view.

E. Samples for Verification: For the following products:

1. Countertop material, 6 inches square.
2. Wall panel material, 6 inches square.

1.4 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.5 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID-SURFACE-MATERIAL COUNTERTOPS

A. Configuration: Provide countertops with the following front and backsplash style:

1. Front: Beveled.
2. Backsplash: Beveled.
3. Endsplash: Matching backsplash.

B. Countertops: 1/2-inch- thick, solid surface material with apron and built up front edge of same material.

C. Backsplashes: 1/2-inch- thick, solid surface material.

D. Fabrication: Fabricate tops in one piece with shop-applied edges, aprons and coved backsplashes unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose end splashes for field assembly.

2.2 COUNTERTOP MATERIALS

A. Certified Wood Materials: Fabricate countertop support frames with wood and wood-based products produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Adhesives: Adhesives shall not contain urea formaldehyde.

C. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.

D. Basis-of-Design Product: Subject to compliance with requirements, provide Corian product by E. I. du Pont de Nemours and Company or comparable products by one of the following:

1. Avonite Surfaces.

2. Formica Corporation.
3. Wilsonart International; Div. of Premark International, Inc.

E. Support Brackets: Fabricated stainless steel countertop bracket angle with welded gusset.

1. Minimum load capacity 200 pounds per bracket.
2. Size: 20 inches by 20 inches at lavatory countertops; 10inches by 10 inches at convenience shelf.
3. Manufacturer: Subject to compliance with requirements, provide the following or an equal product.

a. Short Run Pro, LLC; Federal Brace division

1) Model: Brunswick

2.3 QUARTZ-SURFACE WALL PANELS

A. Adhesives: Adhesives shall not contain urea formaldehyde.

B. Quartz Surface Material: Homogeneous mixture containing 93% pure quartz with additions of high performance polymer resins and pigments that are compacted under intense vibration, vacuum, and pressure into dense, non-porous slabs.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Zodiaq product by E. I. du Pont de Nemours and Company or comparable products by one of the following:

1. Caesarstone
2. Cambria.
3. Silestone.

D. Thickness: ¾ inch.

2.4 FINISHES

1. Solid-surface-material countertops: DuPont Corian Illumination Series – Arctic white.
2. Quartz-surface wall panels: DuPont Zodiaq – Calm Spring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with fabricator present for compliance with requirements for installation tolerances, and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Countertops:

1. Install support brackets plumb and level. Provide blocking in wall adequate to support the imposed loads. Provide shims as required to prevent crushing of the wall finish.
2. Construct support frame with continuous members over each bracket and at all perimeter edges.
3. Install countertops plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.

    a. Provide product in the largest pieces available.
    b. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
    c. Exposed joints/seams shall not be allowed.
    d. Reinforce field joints with solid surface strips extending a minimum of 1 inch on either side of the seam with the strip being the same thickness as the top.
    e. Cut and finish component edges with clean, sharp returns.
    f. Rout cutouts to template.
    g. Anchor securely to bracket supports.
    h. Align adjacent countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop.
    i. Carefully dress joints smooth, remove surface scratches and clean entire surface.
    j. Install countertops with no more than 1/8-inch sag, bow or other variation from a straight line.

4. Endsplashes:

    a. Install applied endplashes using manufacturer's standard color-matched silicone sealant.

B. Convenience Shelf:

1. Install support brackets plumb and level. Provide blocking in wall adequate to support the imposed loads. Provide shims as required to prevent crushing of the wall finish.
2. Install plywood sublayer.
3. Install countertops plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.

    a. Provide product in the largest pieces available.
    b. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
    c. Exposed joints/seams shall not be allowed.
    d. Cut and finish component edges with clean, sharp returns.
    e. Carefully dress joints smooth, remove surface scratches and clean entire surface.
    f. Install shelf with no more than 1/8-inch sag, bow or other variation from a straight line.

C. Wall Panels:

1. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data, using compatible adhesive sealants per the manufacturer's written recommendations

    a. Provide product in the largest pieces available.

b. Form vertical seams where necessary using manufacturer's recommended adhesive, with joints inconspicuous in finished work. No horizontal seams shall be allowed.
c. Fabricate reveal field joints as indicated with built up solid surface edges and batten strips.
d. Cut and finish component edges with clean, sharp returns.
e. Carefully dress joints smooth, remove surface scratches and clean entire surface.

3.3 REPAIR

A. Repair or replace damaged work, which cannot be repaired to architect's satisfaction.

3.4 CLEANING AND PROTECTION

A. Keep components clean during installation.

B. Remove adhesives, sealants and other stains.

END OF SECTION 123661

SECTION 124816 - ENTRANCE FLOOR GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes recessed foot grilles and frames.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for slab depression grouting and filling for recessed foot grilles and frames.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide foot grilles and frames capable of withstanding the following loads and stresses:

1. Uniform floor load of 300 lbf/sq. ft..
2. Wheel load of 350 lb per wheel.

1.4 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for foot grilles and frames.

B. Shop Drawings: Show the following:

1. Items penetrating foot grilles and frames, including the following:

a. Door control devices.

2. Divisions between grille sections.
3. Perimeter floor moldings.

C. Samples for Initial Selection: For each type of product involving color selection.

D. Samples for Verification: For each type of product indicated.

1. Foot Grille: 12-inch- square assembled sections.
2. Frame Members: 12-inch- long Sample of each type and color.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For foot grilles and frames to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain foot grilles and frames through one source from a single manufacturer.

B. Accessibility Requirements: Provide installed foot grilles that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1.7 PROJECT CONDITIONS

A. Field Measurements: Indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate size and location of recesses in concrete to receive foot grilles and frames.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ARDEN Architectural Specialties, Inc.
2. Balco, Inc.
3. C/S Group.

2.2 MATERIALS

A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15.

B. Extruded Aluminum: ASTM B 221, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52 as standard with manufacturer. Coat surface of frame in contact with cementitious materials with manufacturer's standard protective coating.

2.3 FOOT GRILLES

A. General: Provide manufacturer's standard foot-grille assemblies consisting of treads of type and profile indicated, interlocked or joined together by cross members, and with support legs (if any) and other components needed to produce a complete installation.

B. Aluminum Foot Grilles: Provide manufacturer's standard foot grilles with extruded members, top-surfaced tread rails, and as follows:

1. Tread Rails: Extruded-aluminum tread rails with extruded-aluminum frame.
2. Tread Rail Spacing: 1-1/2 inches o.c. with 1/8- to 3/16-inch- wide openings between treads.
3. Top Surface: Fusion-bonded, level-cut-pile nylon carpet insert; 1/4 inch high, 28 oz./sq. yd..

    a. Colors: As selected by Architect from manufacturer's full range.

4. Grille Size: As indicated.

C. Lockdown: Manufacturer's standard.

2.4 FRAMES

A. Provide manufacturer's standard frames of size and style for grille type, for permanent recessed installation in subfloor, complete with installation anchorages and accessories. Unless otherwise indicated, fabricate frame of same material and finish as grilles.

2.5 SUPPORT SYSTEM

A. Level Bed Applications: Provide manufacturer's standard, vinyl cushion support system.

2.6 FABRICATION

A. Shop fabricate foot grilles to greatest extent possible in sizes as indicated. Unless otherwise indicated, provide each grille as a single unit; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in grilles are necessary, space symmetrically and away from normal traffic lanes.

B. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and floor conditions for compliance with requirements for location, size, minimum recess depth, and other conditions affecting installation of foot grilles and frames.

B. Examine roughing-in for drainage piping systems to verify actual locations of piping connections before foot grille and frame and drain pan installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install recessed foot grilles and framesto comply with manufacturer's written instructions at locations indicated and with top of foot grilles and frames in relationship to one another and to adjoining finished flooring as recommended by manufacturer. Set foot-grille tops at height for most effective cleaning action. Coordinate top of foot-grille surfaces with doors that swing across grilles to provide clearance under door.

3.3 PROTECTION

A. After completing frame installations, provide temporary filler of plywood or fiberboard in foot-grille recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 124816

SECTION 129300 – SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Bicycle racks
2. Benches
3. Tables and chairs
4. Trash Receptacles
5. Recycling Containers
6. Planters

B. Related Sections include the following:

1. Earthwork for excavation for installation of concrete footings.
2. Cast-in-Place Concrete.

C. Products furnished, but not installed under this Section, include pipe sleeves and anchor bolts to be cast in concrete footings and installed in paving.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each type of exposed finish required, prepared in Samples of size indicated below.

1. Size: Not less than 6-inch- long linear components and 4-inch- square sheet components.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of site furnishing(s) through one source from a single manufacturer.

PART 2 - PRODUCTS

2.1 BICYCLE RACKS

A. Provide single loop bike rack as manufactured by Landscape Forms, Inc.

1. Model: Ring Bike Rack.

B. Finish: Stainless Steel.

C. Mounting: As shown on plans.

2.2 BENCHES

A. Provide bench as manufactured by Landscape Forms, Inc.

1. Model: Plexus II.

B. Frame Color: Titanium.

C. Mounting: As shown on plans.

D. Length: 6 feet.

E. Seat Type: Wire grid.

2.3 TABLES AND CHAIRS

A. Provide table as manufactured by Landscape Forms, Inc.

1. Model: Plexus II

B. Frame Color: Titanium.

C. Mounting: Surface mount.

D. Seat Type: Wire grid.

E. Table Top: Perforated Steelhead.

2.4 TRASH RECEPTACLES

A. Provide receptacle as manufactured by Landscape Forms, Inc.

1. Model: Plexus II.

B. Color: Titanium.

C. Mounting: Surface mount.

D. Lid: Spun top with side opening and ash tray.

2.5 RECYCLING CONTAINERS

A. Provide receptacle as manufactured by Landscape Forms, Inc.

1. Model: Plexus II.

B. Color: Ocean.

C. Mounting: Surface mount.

D. Lid: Spun top with side opening without ash tray.

E. Decal: Provide white recycling logo.

2.6 PLANTERS

A. Provide planters as manufactured by Greenform (310.663.3995).

1. Model: Delta 60 - Round

B. Color: Anthracite.

C. Size: 30” diam x 24” height.

2.7 PLANTER IRRIGATION SYSTEMS

A. Provide one reservoir irrigation unit per planter manufactured by Tournesol (www. Tournesolsiteworks.com)

B. Contractor to coordinate selected planter make and model with Tournesol. Tournesol to provide cut sheet of proposed reservoir unit to landscape architect for approval.

2.8 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

E. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.9 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 ALUMINUM FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.11 STEEL AND GALVANIZED STEEL FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

E. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

3.3 CLEANING

A. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION 129300

SECTION 130390 - CONTROLLED ENVIRONMENT ROOMS

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, and Drawings apply to work of this Section.

B. This Section includes, but is not limited to, all materials, labor and equipment, complete with all anchors and related accessory, necessary to furnish, deliver and install:
   1. +4°C Cold Room

C. Related Sections:
   1. Divisions 22 & 23 - Mechanical: Fire protection and plumbing piping.
   2. Division 26 - Electrical: Conduit and wiring to points of connection in junction box on exterior of controlled environment rooms.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Manufacturer is responsible for engineering cooling system, including but not limited to selecting the controls and sizing the equipment, to meet the performance requirements.
   2. Door-opening temperature recovery period: Following a 15 second door opening, the room temperature shall recover within 3 minutes.
   3. Manufacturer is responsible for designing units, including refrigeration system, anchorage to structural system and necessary modifications to meet specified requirements, and shall maintain visual design concepts.
   4. Drawings are diagrammatic and are intended to establish basic dimension of units, sight lines, and profiles of units.
   5. The walk-in room contractor is responsible for physically measuring the area to assure that their equipment will fit in the designated location. Any dimensional corrections will be accomplished at no change in contract sum.
   6. Provide concealed fastening whenever possible.
   7. Attachment considerations: Account for site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening and fracturing connection between piping and units.
   8. Modular constructed room incorporating wall, roof-ceiling, and floor panels.
   9. Panels consisting of interior and exterior metal skins with an insulation core.
   10. Incorporate integral mechanical method of fastening and sealing joints between panels to provide vapor-tight seal.
   11. Allow for disassembly for possible relocation or expansion at a later date.
   12. Prefabricated, metal clad, sectionally constructed and designed for easy and accurate field assembly and interchanging.
   13. Provide unit complete with electrical devices such as receptacles, boxes, conduit, wiring, light fixtures, switches, surface mounted wiremold with duplex 120 Volts, 20 Amp receptacles, Tel/data outlets, power and control wiring, and power and control mechanisms, terminated at a single point on exterior of controlled environment rooms, for each voltage for connection to power supply. All materials in accordance with Division 26 – Electrical.
   14. Standards:
      a. The controlled environment room design and installation shall conform to ADA and all other applicable codes, ordinances and regulations.

b. Control panel shall be tested and certified by a Nationally Recognized Testing Laboratory to be constructed and documented in accordance with UL 508 and NFPA 79 (Electrical Standard For Industrial Machinery).

15. Refrigeration system:
    a. Size refrigeration piping integral with equipment.
    b. Size refrigerant pipe lines for distance between evaporator and condensing units.
    c. Provide interconnecting piping, including piping insulation. Provide piping and insulation materials per refrigeration equipment manufacturer's recommendations. Coordinate with other trades.
16. Electric power requirements:
    a. Condenser units shall operate at 208 volts, 3 phase
    b. Control Panel Power Source shall be 208 Volts, 3 phase, 4 wire, 30 Amp circuit to power auxiliaries such as, lights, heaters, controls, etc.
    c. Provide wiring between evaporator and condenser unit as required for unit controls.
    d. Provide fused disconnect switches for the compressors and a main disconnect switch for the control panel.
    e. All electrical materials shall be in accordance with Division 26 – Electrical.
17. Performance Requirements:
    a. Refrigeration system:
        1) Provide continuous operation at the setpoint conditions and within the specified tolerances with the following heat loads present in any combination:
            a) 10 watts/sq.ft. from receptacles
            b) Lighting on
            c) Personnel present in room and door openings as indicated
            d) Make-up air as scheduled
            e) Ambient conditions +24°C / 50% RH
            f) Compressor located in + 40°C ambient
        2) Provide equipment and controls for evaporator defrost cycle as required.
        3) Achieve and maintain individual room operating temperature requirements and performance.
18. Fire Resistance Requirements:
    a. Panel insulation flame spread: ASTM E84; 25 or less.
    b. Panels to have Class I rating when tested in accordance with FM 4880.
19. Structural Requirements:
    a. Design and fabricate wall panels to support roof-ceiling panels.
    b. Design and fabricate roof-ceiling panels to support roof and ceiling mounted equipment, and service technician.
20. Thermal Requirements:
    a. Refer to Schedule Article for initial temperature setting.
    b. Maximum temperature variation from setting: 0.5°C at any point in the room.

B. Interface with Adjacent Systems. The following items are incidental to this Section and provided by other Specification Sections:
1. Division 22:
    a. Sprinkler piping.
    b. Condenser water supply & return.
2. Division 26:
    a. Power rough-in and final connection of all power circuits to the controlled environment rooms junction boxes on top of the units.
    b. Remote alarm monitoring wiring and conduit, as directed by the Owner.

1.3 SUBMITTALS

A. General: Submit in accordance with Division 01.

B. Product Data:
   1. Submit product data for insulation materials, panel facing materials, refrigeration equipment, lighting, audio-visual alarm, and recording instrumentation.
   2. Include information for factory finishes, hardware, glass, sealants, accessories, and other required components.
   3. Include name of refrigerant/condenser manufacturer.

C. Shop Drawings:
   1. Indicate layout including sections and elevations with dimensions.
   2. Submit detail drawings of materials, construction, anchorage devices, and finishes.

D. Samples:
   1. Finished exterior panel metal skin:
      a. Two pieces 6” x 6”
   2. Finished Floor Samples:
      a. Color samples of not less than ten (10) standard manufacturer’s colors
      b. Architect will select color from manufacturers’ standard colors. Multiple colors may be selected at no change in contract sum.

E. Submit following Informational Submittals:
   1. Test Reports: Submit written results of testing specified as part of Source and Field
   2. Quality Control articles.
   3. Qualification Data: Manufacturer's and installer's qualification data.
   4. Manufacturer's instructions.

F. Closeout Submittals:
   1. Submit under provisions of Division 01.
   2. Project record documents: Record actual locations of mechanical and electrical components, piping, ducts and writing.
   3. Special Documentation Requirements:
      a. Labeling of Conductors: Ungrounded current carrying conductors shall be labeled as follows:
         1) Field installed conductors shall be numbered at both ends with the same number. Conductors within the control panel shall be numbered in the same fashion.
         2) Numbered conductors shall have discrete number labels which are not found on any other conductor on the controlled environment room.
         3) The number labels on each numbered conductor shall correspond to labels on the control panel component layout and control system schematic drawings which indicate the point of connection of each labeled conductor.
   4. Control System Documentation: The following documentation is required at project completion. It shall be provided in addition to any requirements of the project general conditions. All documentation shall illustrate or describe the as-built condition of the completed work. Provide 2 complete sets of documentation for each room installed. Each set shall be delivered in a three ring binder with the project name and room identifier on the cover
      a. Drawings of the completed installation showing locations of all equipment ad fixtures.
      b. Refrigeration piping schematic.
      c. Compete parts list with all control and refrigeration system parts and the original manufacturer’s name and part numbers
      d. Control panel wiring diagram indicating the terminal connections for all ungrounded conductors. All conductor label numbers shall be indicated on the

drawings. Conform with other control system documentation requirements of this section.

e. Control panel interior component layout drawing indicating the numbered wire connections and terminal connection locations for each component. Conform with other control system documentation requirements of this section.

5. Approved copy of operating procedures manual and maintenance data.
6. Warranty: Submit specified warranty.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility:
   1. Furnish rooms from one manufacturer for entire Project, unless otherwise indicated.
   2. Provide each room as complete unit, including equipment and component items necessary for proper operation.

B. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum 5 years documented experience.

C. Installer Qualifications: Acceptable to manufacturer with documented experience on at least 5 projects of similar nature in past 5 years.

1.5 PRE-INSTALLATION CONFERENCE

A. Conduct pre-installation conference in accordance with Division 01.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Division 01.

1.7 SEQUENCING

A. Sequence work under provisions of Division 01.

B. Coordinate installation of fire sprinklers, piping, refrigeration lines and condensate drain line with respective sections of division 22.

C. Coordinate installation of electric power conduit and wiring with respective sections of Division26.

1.8 WARRANTY

A. Comply with provisions of Division 01.

B. Warrant installed room to be free from defects in material and workmanship for 2 years from date of substantial completion.

C. Warrant refrigeration system to be free from defects in material and workmanship for 5 years from date of substantial completion.

D. Include coverage against defects which may arise during the warranty period except those which are caused by misuse.

1.9 MAINTENANCE

A. Service: Provide service and maintenance of room and components for 12 months from date of Substantial Completion to maintain warranty conditions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Thermmax Scientific Products, Colmar, PA
   2. Climate Technologies, Laytonsville, MD.
   3. Environmental Growth Chambers, Chagrin Falls, OH

2.2 MATERIALS

A. Aluminum, Extrusions:
   1. ASTM B221M (B221).
   2. Alloy: 6063-T5.

B. Galvanized Carbon Steel Sheet:
   1. ASTM A446/A446M.
   2. Coating Thickness: Z185 (G60).

C. Stainless Steel:
   1. ASTM A167.
   2. UNS Number S30200.
   3. Finish: Number 4.

D. Panel Insulation: Foamed-in-place urethane having a thermal conductivity ("K" Factor) not exceeding 0.125 BTU/Hr/Sq.Ft./degree F/inch of thickness (0.019W/(m*K)) The overall coefficient of heat transfer ("U" Factor) shall not exceed .034 (R-30.1) for 4 inch thick walls. Other thickness shall have corresponding higher or lower value. Insulation density shall be 2 lb./cu.ft. minimum.

2.3 COMPONENTS

A. Size:
   1. Length: See drawings.
   2. Depth: See drawings.
   3. Height: 9'-4" nominal exterior height.

B. Panels:
   1. Panel Thickness: 4 inches including metal skin and finish thickness.
   2. Manufacturer's standard and custom sized panels to provide layout, dimensioned on drawings, or to within 2" of adjacent building walls if no dimensions are given.
   3. Fabricate without wood components.
   4. Compose entire panel section of panel insulation except for metal skins and internal structural interlock and framing.
   5. Fabricate wall and roof-ceiling panels with integral structural support blocking capable of supporting refrigeration equipment.
   6. Fabricate edges of tongue and groove profile.
   7. Fabricate panels with foamed-in-place gaskets on each edge to assure airtight seals.
   8. Fabricate panels with manufacturer's standard joining devices and panel locks.
   9. Provide 1.57 rad (90 degree) corner panel units for each corner.
   10. The floor panels shall be clad on the interior and exterior with the specified metal skin and utilize urethane insulation. The floor panels shall allow fastening to the wall

panels, and shall be able to withstand uniformly distributed floor loads up to, and including 600 lbs/sq.ft.

11. Floor Covering: All walk-in room floors shall be covered with a crevice-free, non-absorbent, slip-resistant, abrasive vinyl (90% virgin vinyl matrix) floor covering Altro Walkway 20 or approved equal, inlaid type having temperature stability, dimensional stability and flexibility from -40°C to +60°C. Flooring shall be smooth, free of ribs or patterns. Flooring shall require no maintenance except cleaning with detergent and water. Depending upon room size, floors shall be seamless or seams shall be welded. Floor covering shall be coved up the walls 4 inches high, capped with a vinyl trim piece, and continuously silicone sealed between vinyl cap and walls. Floor covering color shall be selected by Architect.
12. Closure panels: Match sheet metal of exposed exterior panel skin.

C. Insulation:
1. Nominal 4 inches urethane foam in floors and walls and ceilings and –20°C freezer room.

D. Door:
1. One 36" x 77" minimum clear opening dimension of the doorway.
2. Door shall be provided with cylinder lock, door closer, interior safety latch, and chrome hardware.
3. Construct door same as wall panels.
4. Align door faces flush with faces of wall panels.
5. Door Vision Light: (W) 12” x (H) 18" minimum. Multi-pane assembly, designed to prevent the formation of condensation on the glass or frame under the performance criteria. The window shall be removable for replacement.

E. Hardware:
1. Material: Chrome plated steel, stainless steel, or aluminum.
2. Finish: Satin texture.

F. Hinges:
1. Swing clear configuration to not allow door thickness to obstruct door's clear opening.
2. Provide minimum of three hinges per door.

G. Latch:
1. Provide with cylinder lock.
2. Provide with interior safety release handle connected to lock mechanism to prevent people from being locked inside.
3. Mounting Height: Between 36 and 48 inches above floor surface.

H. Closer:
1. Closing time: Minimum of three seconds to move from 1.22 rad (70 degree) open position to 3 inches from latch, measured from leading edge of the door.
2. Maximum door opening force: 22 N (5 pounds) and as required by ADA guidelines.

I. Gasket:
1. Head and jambs: Thermoplastic with magnetic steel core.
2. Sill: Thermoplastic sweep.

J. Signage: Place card to remind user of hazard caused by spilled specimens and water on room's floor.

K. Condensation and frost prevention heaters:

1. Door and frame assembly shall remain free of condensation under the specified room operating conditions.

L. Lighting:
1. Furnished and install lighting fixtures in each room in an arrangement which will attain the illumination levels specified. Rooms with minimum operating temperatures below 0°C shall be provided with incandescent light fixtures. All others shall be provided with fluorescent fixtures.
2. Fixture Types:
a. Fluorescent fixtures shall have electronic ballasts rated for operation at the maximum low temperature at the location where they are installed. Fixtures shall be weatherproof type with non-metallic housing and gasketed lens. Each fixture shall accommodate two 48" size T-8 lamps. Provide 75 lx (70 foot candles) of illumination at 40 inches above the floor measured at + 25°C.

M. Furnish and install all electrical items in Controlled Environment Rooms as indicated on Electrical Drawings. All materials shall be in accordance with Division 26 – Electrical specifications.

2.4 FINISHES

A. Exterior: Factory applied baked white polyester on galvanized steel. Galvalume will not be acceptable.

B. Interior: Factory applied baked white polyester on galvanized steel. Galvalume will not be acceptable.

2.5 EQUIPMENT

A. All equipment and componentry shall be listed by a NRTL (Nationally Recognized Testing Laboratory) to be suitable for application to which it is applied on this project. Major assemblies, including condensing units and control panels shall be tested and labeled by a NRTL in accordance with a suitable applicable nationally recognized standard.

B. Pressure Relief Port:
Pressure relief ports shall be utilized for all rooms operating at a temperature of -17.8°C (0°F) or below. The relief port shall be provided to equalize the difference in exterior and interior pressure caused by sudden temperature changes. The relief port shall be heated to prevent freezing.

C. Refrigeration system:
1. All rooms shall be provided with mechanical cooling system as specified herein. The refrigeration system shall be an integral part of the control and conditioning system. Condensing unit shall be located on the exterior ceiling of each room. All piping and wiring between remote components and rooms shall be installed by the manufacturer. Coordinate final connections to building services with plumbing, mechanical and electrical contractors.
a. The compressor condensing unit shall consist of an air-cooled accessible semi-hermetic compressor. Include all components necessary to accomplish effective, efficient, serviceable installation. System shall consist of, but not limited to, accessible semi-hermetic compressor, receiver, condenser, evaporator, moisture indicating sight glass, liquid filter-drier, high and low pressure controls, crankcase pressure regulator, suction accumulator, suction line filter, expansion valve, oil level, sight glass, condenser pressure regulator, manual shut-off valves and all interconnecting piping, insulation and wiring. Unit shall be designed for continuous operation for maximum compressor life.

b. System capacity control shall be accomplished with hot gas bypass which continuously mixes liquid and gaseous refrigerant to achieve the selected performance of the system.
c. Condensing units shall be provided with automatic reset high and low pressure controls.
d. Provide 2-way or 3-way (as required by condenser water design) condenser water regulating valve.
e. Provide solenoid valves for operation with a manual pump down switch included with the main control panel.
f. Ceiling Conditioning Unit: The air in the room shall be conditioned by a ceiling mounted conditioning unit. It shall contain all interior cooling, heating, and air moving equipment within a housing fabricated of smooth white aluminum. Service to the internal components shall be via removable panels on the housing. The bottom of the housing shall serve as a condensate drain pan. The conditioning unit shall be completely pre-assembled, and tested prior to shipment, requiring only field connection to controller and condensing units. Mount condenser on base with vibration isolators.
g. Air movers shall be aluminum bladed fans with permanently lubricated motors. Evaporator coil shall be fabricated of copper tubes and aluminum fins. Suspend unit from roof-ceiling panels, and provide connection for condensate drain pipes to drip pan.
h. Condensate drain pan shall be heated on all units with operating temperature range extending below 0°C.

2.6 ACCESSORIES

A. Shelving:
Provide full height adjustable shelving as indicated on drawings and as specified in section 106710. All shelving units shall be constructed of stainless steel, with a minimum of five years corrosion resistance guarantee.

B. Penetrations for Pipe and Conduit through Panels:
1. Provide for each penetration through room's walls and roof-ceiling.
2. Seal penetrations, from both ends with silicone sealant, to prevent air infiltration into room and insulate to prevent condensation at pipes, conduit, and junction boxes.

2.7 CONTROL CONSOLE

A. Control Console
1. A control console incorporating a key locked door with a clear acrylic window shall be required for viewing and protecting the settable controls. The console shall be mounted on the controlled environment room exterior next to the door if possible. All controls, switches, pilot lights, alarms and temperature recorder shall be housed in a welded control console.
2. All ungrounded conductors in the control panel and their field wired extensions shall be uniquely numbered at each end with a suitably applied label. The labels shall be permanent and machine printed. Hand marking of conductors or application of tapes with hand written markings will not be accepted.
3. Control panel components shall be assigned a name, tag, or other identifier which shall be utilized throughout the system documentation to describe or refer to that component.
4. Complete control panel assembly shall be tested and certified by a NRTL to be in accordance with NFPA 70 and NFPA 79. A certifying label from the testing agency shall be applied to the exterior of each control panel.

B. Temperature Controller:

1. Temperature control shall be through a solid state microprocessor based digital control with RTD sensing. The control components shall control capacity of the refrigeration/conditioning system and be designed to meet the performance criteria of the room. Setpoint shall be through the digital control and readout shall be in degrees Centigrade. The controller shall simultaneously display the actual condition and setpoint.

C. High/Low Temperature Safety Alarms:
1. Separately adjustable high and low limit control circuits shall be provided in the control panel. Limit controllers shall be electronic, with digital setpoint and display of current room temperature. Hydraulic actuated devices, or those with reference dials shall not be permitted. Limit control shall have its own sensor, independent from all others. Provide functions and devices as follows;
   a. High Limit: In the event of a high temperature limit condition, the limit control will de-energize all heat producing devices loaded on the control panel power circuits, illuminate a red pilot light and sound an audio alarm. Additionally, the control circuit shall have a normally open contact wired in series with the compressor contactor control signal to provide immediate and direct shutdown of the compressor. When temperature returns to the normal range the system shall reset by one of the methods below. Reset methods shall be operator selectable with a front panel mounted switch. Provide a normally open and normally closed relay contact for connection to building alarm system.
   b. Low Limit: In the event of a low temperature limit condition, the safety control will directly open the compressor contactor, activate a red pilot light and sound an audio alarm. Limit control circuit shall have a normally open contact wired in series with the compressor contactor control signal. Systems which rely on low pressure switch action to shutdown compressor will not be accepted,. When temperature returns to the normal range the system shall reset by one of the methods below. Reset method shall be operator selectable with a front panel mounted switch. Provide a normally open and normally closed relay contact for connections to building alarm system.
   c. Reset methods for high and low limit:
      1) Manual reset shall prevent restart of the equipment until the operator has pressed a reset button on the control panel face.
      2) Automatic reset will cause the equipment to restart when the room temperature returns to the normal range.
   d. Auxiliary High Limit Safety: On all rooms provided with electric air heating, provide a separate, independent solid state limit control which is UL listed (UL991) as a temperature limit device. This limit control shall monitor air temperature in the conditioning unit, opening the heater power contactor and enabling the audio alarm and a red pilot light if temperature exceeds a preset limit. The preset, non-adjustable limit setpoint shall not exceed +65°C, but shall be high enough to prevent false alarming under normal system operation. The tripped limit control shall require manual reset by operation of a panel mounted push button.

D. Defrost Control:
1. Defrost controls shall be installed on all rooms with specified operating temperature extending below +6°C. Cycle shall consist of controlled heating and then cooling of the evaporator coil, removing any accumulated frost while minimizing the impact on room performance. All rooms shall be defrosted with compressor discharge gas. Defrost cycle control shall be considered an essential element of room operation. Defrost controls shall perform the following functions:
   a. Defrost cycle initiation will automatically be skipped if room temperature is above a preset limit. Limit shall be adjustable on the front of the control panel.

Fans shall be off during the heating phase of the cycle. Initiation of the heating portion shall be accomplished in two ways:

1) Operator can manually initiate a defrost cycle with a switch on the control panel face. Cycle shall start immediately upon operation of the switch.
2) An electronic timing device shall automatically initiate defrost cycles at predetermined adjustable intervals

b. Four methods of terminating the heating portion of the cycle shall be provided:

1) Termination shall occur when evaporator temperature or suction pressure reaches a preset adjustable level.
2) An increase in room air temperature by a predetermined amount shall cause the heating portion of the cycle to terminate. This maximum room temperature rise limit shall be adjustable on the control panel face.
3) The expiration of a preset time period allowed for coil heating shall cause the heating cycle to terminate. This function shall be considered to be a secondary method. Defrost cycles shall normally terminate by the detection of a rise in evaporator temperature or suction pressure.
4) The heating cycle can be manually terminated by the operator. A switch on the control panel face shall be provided for this function. Operation of the switch shall immediately terminate an active defrost cycle.

c. After the heating cycle is terminated, the evaporator shall be cooled to an adjustable fan cut-in temperature and the fan shall begin operation. This function shall be automatically disabled when the room is operating above temperatures where defrost is required.

d. Coordination of the defrost cycle and operation of other heat producing equipment shall be accomplished to minimize the effect on room temperature rise during the defrost cycle.

E. Recorder:

1. Provide a solid state temperature recorder with a seven day or twenty-four hour chart movement which is switch selectable. The recorder shall utilize a 10 inch circular chart. On controlled environment rooms with humidity control, provide a second pen for recording of RH levels with the room. The same sensor shall be utilized for control and to record RH levels with the room. The thermometer shall be calibrated below and above the operating range of the room and the hygrometer shall be calibrated over the range of 10% to 98%. Recorder accuracy shall be 1% full scale.

F. Humidity Control:

1. If desiccant dehumidification of controlled environment rooms is required to achieve specified environmental control parameters, the following control system shall be capable of maintaining selected relative humidity within specified limits. The system shall control humidity through a microprocessor based digital controller with readout in percentage RH. The RH sensor shall be a variable capacitance sensor or hygroscopic plastic foil sensor, temperature compensated and calibrated over the entire range of the room Sensor shall be located within the room air flow to provide maximum sensitivity and fast response to changes within the room. Wet bulb/dry bulb, lithium chloride, gold grid, bulk resistance or similar sensors shall not be accepted.

2.8 MECHANICAL DESIGN

A. Fresh Air Exchange:

Controlled environment rooms shall be provided with inlet and outlet connections for fresh air supply and exhaust from the building HVAC system. Air flow rate shall be as scheduled,

and shall be continuous. Provide an insulated enclosure on the exterior ceiling of the room containing auxiliary heating/cooling coil with the necessary controls as part of the controlled environment conditioning system. The auxiliary coil shall automatically heat or cool the fresh air supply to the current room setpoint before the air enters the room. Provide condensate removal system, temperature controls, and all necessary materials and labor for a complete installation.

B. Humidification:
Controlled environment rooms shall utilize independent steam generators. Electrically heated generators shall have an automatic safety device to shut down system in case of water cut off. Steam shall enter the room air stream through a stainless or copper plenum mounted steam head.

C. Dehumidification:
Controlled environment rooms utilizing an automatic regenerative desiccant drier for lowering of humidity from ambient to the minimum humidity level specified shall automatically modulate the amount of dry air needed from the regenerative drier to prolong equipment life and lower operating costs. Dryer shall be furnished complete with ductwork and dampers.

2.9 SPECIAL REQUIREMENTS

A. +4°C Walk-In Cold Room
1. Use: Storage
2. Temperature Range: +4°C
3. Relative Humidity: Maximum 65%
4. Number of people working in room at one time: 2
5. Door openings: Personnel entering and leaving the room at a rate of 6 openings per hour
6. Special Requirements:
   a. Stainless Steel Shelving as shown on drawings.
7. Electrical Devices Within Room:
   a. See Electrical Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with Division 01.

B. Verify mechanical and electrical services to room are roughed-in and ready for connection to room equipment, plumbing, and wiring.

3.2 INSTALLATION

A. Install in accordance with Division 26, and approved shop drawings.

B. Install units plumb, level, square, and free from warp and twist while maintaining dimensional tolerances and alignment with surrounding construction.

C. Fabricate panels with manufacturer's standard joining devices.

D. Join panel edges to each other using steel straps set in panel insulation.

E. Field wire electrical devices to a single point for each voltage for connection to outside power supply and monitoring devices.

F. Closure Panels: Provide closure panels, to match sheet metal of exposed exterior panel skin, where space exists between room's walls and roof and building's walls, columns, and ceiling.

G. Interface With Other Work:
1. Coordinate with Divisions 22 & 23:
   a. Sizing and location of condenser-to-evaporator or piping
2. Coordinate with Division 26:
   a. Location of power connection to outside power supply.
   b. Remote monitoring devices.
3. Penetrations for Pipe and Conduit through Panels:
   a. Coordinate with respective trades.
   b. Seal penetrations to prevent air infiltration and condensation.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
1. Comply with requirements of Division 01.
2. Operational Function Testing:
   a. Simulate and verify all alarm and limit functions
   b. Operate and verify all defrost functions and their coordination with other room functions.
   c. Verify operation of all specified functions and switches.
   d. Prepare a detailed written report indicating the step by step procedure used to perform tests. Indicate the specific results of each step.
3. Performance Testing:
   a. All rooms shall be tested for compliance with the specified thermal requirements. Test and measure each room for compliance with specified Thermal Requirements using digital data logger and at least 6 sensors widely spaced throughout the room. Test duration shall be minimum 24 hours per room. Sampling interval shall be less than 3 minutes. Turn over raw data, plotted data and analysis to Architect for approval. Additionally, test for door opening recovery time and defrost temperature rise.
   b. Rooms with relative humidity control shall be tested for humidity control performance and recovery.
   c. Test instrumentation shall have documented accuracy sufficient to effectively test the rooms. Submit calibration report as evidence of accuracy. Resolution shall be 0.1°C or better for temperature, 1% for relative humidity.
   d. Test setpoints for temperature:
      1) Rooms with a temperature span (difference between highest and lowest operating temperatures) of 10 degrees or less shall be tested at the midpoint of the temperature range or the indicated operating temperature.
      2) Rooms with a temperature span greater than 10 degrees, but less than 21 degrees, shall be tested at the highest and lowest setpoints in the range.
      3) All other rooms shall be tested at the highest, lowest and midpoint operating temperature setpoints.
   e. Test conditions for relative humidity:
      1) Rooms with a single operating point shall be tested at that point.
      2) All other rooms shall be tested at the highest and lowest temperature and relative humidity combinations scheduled. This requires testing at 4 possible combinations of high and low temperature and humidity conditions.
4. Refrigeration system testing:

a. Clean, pressure test, dehydrate, and separately vacuum test unit.
b. Test Duration: 5 Hours.
c. Perform the following number of times: One.
d. Pressure test minimum of 690 kPa (100 pounds per square inch) above operating pressure.
e. Vacuum test at 96.5 kPa (28.5 inches of mercury) or less.
f. Charge system with required amount of refrigerant and oil then retest system.

5. Deficiencies in performance or operation evidenced by the tests shall be remedied by the manufacturer and the room shall be re-tested.

3.4 ADJUSTING

A. Adjust parts for smooth, uniform operation.

3.5 CLEANING

A. Clean as required by manufacturer. Do not use materials and methods which may damage finish and surrounding construction.

3.6 DEMONSTRATION

A. Provide system demonstration at mutually agreed upon time to Owner.

B. Demonstrate refrigeration system maintenance control and alarm operations.

3.7 PROTECTION

A. Protect finished work in accordance with Division 01.

END OF SECTION 130390

SECTION 140800 ELEVATOR SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment Start-Up and Functional Performance Testing.

B. Validation of proper and thorough installation of Division 14 - elevator systems and equipment.

C. Generic Start-Up Documentation for electrical systems and equipment.

D. Development of final Start-Up Documentation for electrical systems and equipment.

E. System Start-Up and Turn-Over procedures.

F. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

A. Commissioning (Commissioning) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section outlines the Cx procedures specific to the Division 14 Contractors. Requirements common to all Sections are specified in Sections 019113 and 019114. This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

1.3 SCOPE

A. The following elevator system features/functions are included in the Scope of Commissioning for this project:

1. Security Card Reader
2. Battery-powered Lowering
3. Emergency Communication System
4. Firefighters' Two-Way Telephone Communication System
5. Smoke/Heat Detector Initiated Emergency Recall System

1.4 RELATED WORK AND DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. The Cx process references many related Sections, particularly Section 019113 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 019113.

C. Refer to Section 019113 for a complete list of Sections on Related Work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

A. National Electric Code (NEC)

B. American Society for Testing and Materials (ASTM)

C. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. International Electrical Testing Association (NETA)

F. National Electrical Manufacturers Associates (NEMA)

G. National Fire Protection Association (NFPA)

H. Underwriters Laboratory, Inc. (UL)

I. Refer to Section 019113 for additional Reference Standards.

1.7 DOCUMENTATION

A. Documentation shall be as required in Section n 019113. In addition, Contractor shall also provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

a. AHJ Approval Certificate and Inspection Reports

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 14.

B. Construction Phase

1. Coordinate the checkout of the elevator systems and interfaces and the approval of the regulatory authorities with the Cx process.

C. Acceptance Phase

1. Assist CA in Functional Performance Testing.

1.9 START-UP DOCUMENTATION

A. Refer to Section 019113.

1.10 FUNCTIONAL PERFORMANCE TESTING

A. For applicable systems and equipment, Contractor shall participate in all Cx tests.

1.11 TRAINING

A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

1.12 O&M DOCUMENTATION CONTENT - PREPARATION AND LOGISTICS

A. Refer to Section 019113 the individual Specifications

PART 2 - PRODUCTS

2.1 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines 'generic' or minimally acceptable Start-Up Documentation (which are defined to include both 'Start-Up Checks' and 'Start-Up Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 019113 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.

3.2 START-UP CHECKS COMMON TO ALL SYSTEMS

A. The following Start-Up verifications and procedures shall be considered common to all systems:

1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
2. Verify labeling is affixed per specification and visible.
3. Verify prerequisite procedures are done.
4. Inspect for damage and ensure none is present.
5. Verify system is installed per the manufacturer's recommendations.
6. Verify system has undergone Start-Up per the manufacturer's recommendations.
7. Verify that access is provided for inspection, operation and repair.
8. Verify that access is provided for eventual replacement of the equipment.
9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
10. Verify that the installation ensures safe operation and maintenance.
11. Verify all rotating and moving parts are properly lubricated.
12. Verify all monitoring and ensure all alarms are active and set per Owner's requirements.

3.3 SECURITY CARD READER

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 14 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Tests: During start-up, perform procedures specified in manufacturer's instructions.

1. Demonstrate proper operation of the Security System Card Reader installed in elevator cabs.

3.4 BATTERY-POWERED LOWERING

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 14 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Tests: During start-up, perform procedures specified in manufacturer's instructions.

1. Demonstrate proper operation of the Battery-powered Lowering System.

D. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.5 EMERGENCY COMMUNICATION SYSTEM

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 14 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Tests: During start-up, perform procedures specified in manufacturer's instructions.

1. Demonstrate proper operation of the Emergency Communication System.

D. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.6 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SYSTEM

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 14 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Tests: During start-up, perform procedures specified in manufacturer's instructions.

1. Demonstrate proper operation of the Firefighters' Two-Way Telephone Communication System.

D. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.7 SMOKE/HEAT DETECTOR INITIATED EMERGENCY RECALL SYSTEM

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 14 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Tests: During start-up, perform procedures specified in manufacturer's instructions.

1. Demonstrate proper operation of the Smoke/Heat Detector Initiated Emergency Recall System.

D. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

END OF SECTION 140800

SECTION 142400 - HYDRAULIC ELEVATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes hydraulic passenger and service elevators.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
2. Section 051200 "Structural Steel Framing" for the following:

    a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
    b. Hoist beams.
    c. Structural-steel shapes for subsills that are part of steel frame.

3. Section 055000 "Metal Fabrications" for the following:

    a. Attachment plates and angle brackets for supporting guide-rail brackets.
    b. Hoist beams.
    c. Structural-steel shapes for subsills.
    d. Pit ladders.
    e. Cants in hoistways made from steel sheet.

4. Section 096519 “Resilient Tile Flooring” for finish flooring in elevator cars.
5. Section 221429 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
6. Section 271500 "Communications Horizontal Cabling" for telephone service for elevators.
7. Section 283111 "Digital, Addressable Fire-Alarm System" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.

1.3 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

B. Service Elevator: A passenger elevator that is also used to carry freight.

1.4 ACTION SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoistway entrances, and operation, control, and signal systems.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment.
2. Include large-scale layout of car-control station.
3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

C. Samples for Initial Selection: For finishes involving color selection.

D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch- square Samples of sheet materials; and 4-inch lengths of running trim members.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Furnish well casing and coordinate delivery with related excavation work.

C. Coordinate locations and dimensions of other work relating to hydraulic elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
2. Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Otis Elevator Co.
2. Schindler Elevator Corp.
3. ThyssenKrupp Elevator.

B. Source Limitations: Obtain elevators from single manufacturer.

1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Elevator Number(s): E1.
2. Type: Under-the-car single cylinder.
3. Rated Load: 3500 lb.
4. Rated Speed: 125 fpm.
5. Operation System: Selective-collective automatic.
6. Travel: 14'-0"
7. Landings: 2 total
8. Openings:

    a. Front: 2

9. Auxiliary Operations:

    a. Battery-powered lowering.

10. Car Enclosures:

    a. Inside Width: 80 inches from side wall to side wall.
    b. Inside Depth: 65 inches from back wall to front wall (return panels).
    c. Inside Height: 96 inches to underside of ceiling.
    d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
    e. Car Fixtures: Satin stainless steel, No. 4 finish.
    f. Side and Rear Wall Panels: Plastic laminate.
    g. Reveals: Satin stainless steel, No. 4 finish.
    h. Door Faces (Interior): Satin stainless steel, No. 4 finish.
    i. Door Sills: Nickel silver, polished.
    j. Ceiling: Satin stainless steel, No. 4 finish.
    k. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
    l. Floor prepared to receive resilient flooring (specified in Section 096500 "Resilient Flooring").

11. Hoistway Entrances:

    a. Width: 42 inches.
    b. Height: 84 inches.
    c. Type: Single-speed center opening.
    d. Frames: Satin stainless steel, No. 4 finish.
    e. Doors: Satin stainless steel, No. 4 finish.
    f. Sills: Nickel silver, polished.

12. Hall Fixtures: Satin stainless steel, No. 4 finish.
13. Additional Requirements:

    a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
    b. Provide hooks for protective pads in all cars and two complete set(s) of full-height protective pads.

C. Elevator Description:

1. Service Elevator Number(s): E2.
2. Type: Under-the-car single cylinder.
3. Rated Load: 4500 lb.
4. Freight Loading Class for Service Elevators: Class A.
5. Rated Speed: 125 fpm.
6. Operation System: Selective-collective automatic.
7. Travel: 28'-0"
8. Landings: 3 total
9. Openings:

    a. Front: 3
    b. Rear: 3

10. Auxiliary Operations:

    a. Battery-powered lowering.

11. Car Enclosures:

    a. Inside Width: 68 inches from side wall to side wall.
    b. Inside Depth: 94 inches from back wall to front wall (return panels).
    c. Inside Height: 96 inches to underside of ceiling.
    d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
    e. Car Fixtures: Satin stainless steel, No. 4 finish.
    f. Side and Rear Wall Panels: Plastic laminate.
    g. Reveals: Satin stainless steel, No. 4 finish.
    h. Door Faces (Interior): Satin stainless steel, No. 4 finish.
    i. Door Sills: Nickel silver, polished.
    j. Ceiling: Satin stainless steel, No. 4 finish.
    k. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
    l. Floor prepared to receive resilient flooring (specified in Section 096500 "Resilient Flooring").

12. Hoistway Entrances:

    a. Width: 48 inches.
    b. Height: 84 inches.
    c. Type: Two-speed side sliding.
    d. Frames: Satin stainless steel, No. 4 finish.
    e. Doors: Satin stainless steel, No. 4 finish.
    f. Sills: Nickel silver, polished.

13. Hall Fixtures: Satin stainless steel, No. 4 finish.

14. Additional Requirements:

    a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
    b. Provide hooks for protective pads in all cars and two complete set(s) of full-height protective pads.

D. Elevator Description:

1. Elevator Number(s): E3.
2. Type: Under-the-car single cylinder.
3. Rated Load: 3500 lb.
4. Rated Speed: 125 fpm.
5. Operation System: Selective-collective automatic.
6. Travel: 42'-0"
7. Landings: 4 total
8. Openings:

    a. Front: 4

9. Auxiliary Operations:

    a. Battery-powered lowering.

10. Security Features: Card-reader operation for access to Penthouse level.
11. Car Enclosures:

    a. Inside Width: 80 inches from side wall to side wall.
    b. Inside Depth: 65 inches from back wall to front wall (return panels).
    c. Inside Height: 96 inches to underside of ceiling.
    d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
    e. Car Fixtures: Satin stainless steel, No. 4 finish.
    f. Side and Rear Wall Panels: Plastic laminate.
    g. Reveals: Satin stainless steel, No. 4 finish.
    h. Door Faces (Interior): Satin stainless steel, No. 4 finish.
    i. Door Sills: Nickel silver, polished.
    j. Ceiling: Satin stainless steel, No. 4 finish.
    k. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
    l. Floor prepared to receive resilient flooring (specified in Section 096500 "Resilient Flooring").

12. Hoistway Entrances:

    a. Width: 42 inches.
    b. Height: 84 inches.
    c. Type: Single-speed center opening.
    d. Frames: Satin stainless steel, No. 4 finish.
    e. Doors: Satin stainless steel, No. 4 finish.
    f. Sills: Nickel silver, polished.

13. Hall Fixtures: Satin stainless steel, No. 4 finish.
14. Additional Requirements:

a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
b. Provide hooks for protective pads in all cars and two complete set(s) of full-height protective pads.

2.4 SYSTEMS AND COMPONENTS

A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.

1. Pump shall be submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts.
2. Motor shall have variable-voltage, variable-frequency control.

B. Hydraulic Silencers: System shall have hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.

C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.

1. Cylinder units shall be connected with dielectric couplings.
2. Casing for Underground Piping: Schedule 40 PVC pipe complying with ASTM D 1785, joined with PVC fittings complying with ASTM D 2466 and solvent cement complying with ASTM D 2564.

D. Hydraulic Fluid: Nontoxic, biodegradable, fire-resistant fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives and approved by elevator manufacturer for use with elevator equipment.

1. Product: Subject to compliance with requirements, provide "Hydro Safe" by Hydro Safe Oil Division, Inc.

E. Inserts: Furnish required anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

F. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1/CSA B44, of sufficient size to provide not less than 1-inch clearance from cylinder and extending above pit floor. Casing shall have means of monitoring effectiveness to comply with ASME A17.1/CSA B44.

G. Corrosion-Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler shall be electrically nonconductive, displace or absorb water, and gel or solidify at temperatures below 60 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Hydro Safe Oil Division, Inc.; No-Ox-Id Liquid Elevator Casing Filler E-800.
b. Union-Gard, a division of Dome Services L.L.C.; Union-Gard 160.

H. Car Frame and Platform: Welded steel units.

I. Guides: Roller guides. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.

B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
   1. Single-Car Battery-Powered Lowering: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

C. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

   1. Card-Reader Operation: System uses card readers at car-control stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car.

      a. Security access system equipment is specified in Section 281300 "Access Control."

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

A. General: Provide steel-framed car enclosures with nonremovable wall panels, with removable car roof, access doors, power door operators, and ventilation.

   1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.

B. Materials and Finishes: Manufacturer's standards, but not less than the following:

   1. Subfloor: Exterior, underlayment grade plywood, not less than 5/8-inch nominal thickness.
   2. Floor Finish: Specified in Section 096519 “Resilient Tile Flooring” -.
   3. Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
   4. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to manufacturer's standard honeycomb core with plastic-laminate panel backing and manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 or less, when

tested according to ASTM E 84. Plastic-laminate color, texture, and pattern as selected by Architect from plastic-laminate manufacturer's full range.

5. Fabricate car with recesses and cutouts for signal equipment.
6. Fabricate car door frame integrally with front wall of car.
7. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
8. Sight Guards: Provide sight guards on car doors.
9. Sills: Extruded metal, with grooved surface, 1/4 inch thick.
10. Metal Ceiling: Flush panels, with fluorescent downlights in the center of each panel. Ceiling to have cove lights at left and right sides for depth of cab. Align ceiling panel joints with joints between wall panels.
11. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.

1. Fire-Protection Rating: 1-1/2 hours.

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Stainless-Steel Frames: Formed from stainless-steel sheet.
2. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
3. Sight Guards: Provide sight guards on doors matching door edges.
4. Sills: Extruded metal, with grooved surface, 1/4 inch thick.
5. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

2.9 SIGNAL EQUIPMENT

A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life lamps and acrylic or other permanent, non-yellowing translucent plastic diffusers.

B. Car-Control Stations: Provide manufacturer's standard recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

D. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified inSection 283111 "Digital, Addressable Fire-Alarm System"

E. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

F. Hall Push-Button Stations: Provide one hall push-button station at each landing.

1. Provide units with flat faceplate for mounting with body of unit recessed in wall.
2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.
3. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Section 283111 "Digital, Addressable Fire-Alarm System".

G. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:

1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.

H. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.

2.10 FINISH MATERIALS

A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

E. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

F. Aluminum Extrusions: ASTM B 221, Alloy 6063.

G. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.

H. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications Type BKV for panel backing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Excavation for Cylinder: Drill well hole in each elevator pit to accommodate installation of cylinder; comply with applicable requirements in Section 312000 "Earth Moving."

B. Provide well casing as necessary to retain well-hole walls.

C. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole and provide permanent waterproof seal at bottom of well casing.

1. Fill void space between protective casing and cylinder with corrosion-protective filler.
2. Align cylinders and fill space around protective casing with fine sand.

D. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between protective casing and pit floor with 4 inches of nonshrink, nonmetallic grout.

E. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.

F. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

G. Install piping above the floor, where possible. Install underground piping in casing.

H. Lubricate operating parts of systems as recommended by manufacturers.

I. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

J. Leveling Tolerance: 1/4 inch, up or down, regardless of load and travel direction.

K. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

L. Locate hall signal equipment for elevators as follows, unless otherwise indicated:

1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
2. Place hall lanterns either above or beside each hoistway entrance.
3. Mount hall lanterns at a minimum of 72 inches above finished floor.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

A. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for elevator used for construction purposes:

1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).

B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.6 MAINTENANCE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication,

cleaning, and adjusting as required for proper elevator operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance during normal working hours.
2. Perform emergency callback service during normal working hours with response time of two hours or less.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.

END OF SECTION 142400

RFP No. 612-005, Part B

Request for Proposal

Bioscience Education Center
Phase 2 – Building, Gateway Signage and Road Construction

Germantown Campus

VOLUME 3
Building Construction Specifications

Montgomery College
Maryland

Date: March 26, 2012
Montgomery College
Office of Central Facilities
40 W. Gude Drive – Suite 200
Rockville, MD 20850

Bioscience Education Center
Phase 2 – Building, Gateway Signage and Road Construction
Germantown Campus

TABLE OF CONTENTS

VOLUME I

INTRODUCTORY INFORMATION

PROPOSAL REQUIREMENTS

CONTRACT REQUIREMENTS

VOLUME 2 – BUILDING CONSTRUCTION

TECHNICAL SPECIFICATION SECTIONS

DIV. 08 DOORS AND WINDOWS

DIV. 09 FINISHES

DIV. 10 SPECIALTIES

VOLUME 3 – BUILDING CONSTRUCTION

DIV. 20 RESERVED

200000 Common Mechanical / Electrical Requirements

DIV. 21 FIRE SUPPRESSION

210500 Common Work Results for Fire Suppression
211000 Fire Suppression Commissioning
211200 Fire Suppression Standpipes
211313 Wet-Pipe Sprinkler Systems

DIV. 22 PLUMBING

220500 Common Work Results For Plumbing
220516 Expansion Fittings And Loops For Plumbing Piping
220519 Meters And Gages For Plumbing Piping
220523 General-Duty Valves For Plumbing Piping
220529 Hangers And Supports For Plumbing Piping And Equipment
220553 Identification For Plumbing Piping And Equipment
220700 Plumbing Insulation
220800 Plumbing System Commissioning
221113 Facility Water Distribution Piping
221116 Domestic Water Piping
221119 Domestic Water Piping Specialties
221120 Domestic Water Packaged Booster Pumps
221123 Facility Natural-Gas Piping
221316 Storm Drainage And Sanitary Waste And Vent Piping
221123 Facility Natural-Gas Piping
221316 Storm Drainage and Sanitary Waste and Vent Piping
221319 Sanitary Waste And Storm Piping Specialties
221429 Sump Pump
221513 Laboratory Service Piping
221600 Laboratory Neutralization System
222620 Package Laboratory Vacuum Pump And Receiver
223300 Electric Domestic Water Heaters
223400 Fuel-Fired Domestic Water Heaters
224000 Plumbing Fixtures
224700 Drinking Fountains And Water Coolers
226119 Compressed Air Equipment
226700 Reagent Grade Water System
226710 Purified Water Piping

DIV. 23 HEATING VENTILATION AND AIR CONDITIONING

DIVISION 26 – ELECTRICAL

DIV. 27 COMMUNICATIONS

VOLUME 4 - GATEWAY SIGNAGE

DIVISION 31 – EARTHWORK

DIV. 32 EXTERIOR IMPROVEMENTS

DIV. 33 (NOT USED)

VOLUME 5 – OBSERVATION DRIVE EAST-WEST ROAD AND TRAFFIC CIRCLE

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 02 – EXISTING CONDITIONS

DIVISION 03 – CAST-IN-PLACE CONCRETE

DIVISION 22 - PLUMBING

DIVISION 33 – EARTHWORK

DIVISION 32 – EXTERIOR IMPROVEMENTS

DIVISION 33 – UTILITIES

END OF TABLE OF CONTENTS, PART B

SECTION 200000 - COMMON MECHANICAL/ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Where Paragraphs of this Section conflict with similar paragraphs of Division 01, the more stringent specification requirements shall prevail.

C. This section shall apply to the following Divisions:

1. Division 21 - Fire Suppression
2. Division 22 - Plumbing
3. Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)
4. Division 26 - Electrical
5. Division 27 - Communications
6. Division 28 - Electronic Safety and Security

1.2 SUMMARY

A. Perform work and provide material and equipment as shown on the drawings, as specified and in accordance with this Section. Completely coordinate work of this Division with work of others and provide a complete and fully functional installation.

B. Drawings and Specifications form complimentary requirements. Provide work specified and not shown, work shown and not specified as though explicitly required by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation

C. Give notices, file plans, obtain permits and licenses, pay fees and back charges, and obtain necessary approvals from authorities that have jurisdiction. Perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

D. Examine Drawings and other Sections of Specifications for requirements that affect work of this Section.

E. Attention is directed to the following specialized requirements of this Section:

1. Paragraph GUARANTEE AND 24-HOUR SERVICE. The requirement to provide a 24 hour phone number for service during the guarantee period is incorporated; also, an extended warrantee to cover the full one year contractor's guarantee period starting on the date of beneficial occupancy, even if equipment has been previously used for temporary heat or other purpose.
2. Paragraph RECORD DRAWINGS. A requirement to incorporate photographs, taken during construction, of buried and concealed components is incorporated.

3. Paragraph SUBMITTALS. A special cover sheet for each shop drawing, to be filled out by the contractor, is required. A description of "Acceptable Manufacturers" is included. No other manufacturers will be considered for this project. The turn-around time Vanderweil requires to process shop drawings is described.

4. Paragraph COMMISSIONING OF EQUIPMENT AND SYSTEMS. Requirements for commissioning of systems and equipment, including preparation of a commissioning work plan and commissioning forms, are incorporated.

5. Paragraph COMMISSIONING OF EQUIPMENT AND SYSTEMS. Requirements for commissioning of systems and equipment shall apply to GENERAL COMMISSIONING REQUIREMENTS within Division 01.

1.3 DEFINITIONS

A. As used in all Sections, "provide" means "furnish and install." "Furnish" means "to purchase and deliver to the project site complete with every necessary appurtenance and support," and "Install" means "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project. "Architect" means the "Prime Design Consultant." If R.G. Vanderweil Engineers, LLP is not the prime design consultant, the Architect may authorize R.G. Vanderweil Engineers, LLP to act on the Architect's behalf in matters concerning the all Sections of specifications.

B. "RFI" means "Contractor's Request for Information."

C. Insofar as submittals, reviews, and approvals are concerned, the words “Architect” and “Engineer” may be used interchangeably in the mechanical and electrical divisions.

D. Refer to Division 00 for additional definitions.

1.4 CONTRACT DOCUMENTS

A. Listing of Drawings does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to Architectural, Fire Protection, Plumbing, HVAC, Electrical, Communication, Electronic Safety and Security, Structural, Site Utility and all other Drawings and other Sections that indicate types of construction in which work shall be installed and work of other trades with which work of this Section must be coordinated

B. Refer to Division 00 for additional definitions.

1.5 ELECTRONIC CAD FILES

A. Electronic CAD files for Fire Protection, Plumbing, HVAC, Electrical, Communication, or Electronic Safety and Security drawings will be furnished by Engineer at contractor’s request. These files will be provided on Engineer’s FTP site in the software release used by the Engineer. If other media or software version is requested, Engineer will require advance reimbursement of processing costs.

B. Requests should be made by filling out the following form and providing an authorized signature. The requested information will not be released prior to receipt of the completed Release of Liability Form for the appropriate documents.

DATE

NAME
ADDRESS

Re: JOB# JOB NAME

Dear NAME:

Per the request of **[Owner/Client]**, we are pleased to offer you the following electronic files:

[**Drawing file name, date of file, description**].

Vanderweil Engineers agrees to provide the above-referenced electronic files to **[Addressee]**. **[Addressee]** recognizes that data, plans, specifications, reports, documents, or other information recorded on or transmitted as electronic files are subject to undetectable alteration, either intentional or unintentional, due to among other causes, transmission, conversion, media degradation, software error, or human alteration. Accordingly, the electronic files are provided to **[Addressee]** for informational purposes only and not as an end product or Contract Document. The actual stamped drawings and documents together with any Addenda or revisions are the only true and actual Contract Documents.

Vanderweil Engineers makes no warranties, either express or implied, regarding the fitness or suitability of the electronic files.

Engineer's work done in 2D or 3D CAD is diagrammatic. It is not intended to be absolutely precise; it is not intended to specify or to show every offset, fitting, and component. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, contractor shall provide all other components and materials necessary to make the systems fully complete, coordinated with other systems and the structure and space available, and operational.

Like the actual stamped drawings and documents, the electronic files are instruments of professional service, and shall not be used, in whole or in part, for any project other than that for which they were created, without the express written consent of Vanderweil Engineers.

Accordingly, **[Addressee]** agrees to waive any and all claims against Vanderweil Engineers and **[Owner/Client]** resulting in any way from the use, unauthorized reuse or alteration, or misuse of the electronic files, and to defend, indemnify and hold Vanderweil Engineers and **[Owner/Client]** harmless from any claims, losses, damages, or costs, including attorneys fees, arising out of the use, reuse, alteration, or misuse of the electronic files.

Please acknowledge your acceptance of these terms and conditions by returning a signed original of this letter.

1.6 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are unclear, submit clarification request in writing before Award of Contract. Otherwise, College Project Manager (PM) interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or un-clarities thus resolved.

B. Where Drawings or Specifications do not coincide with manufacturers' recommendations or with applicable codes and standards, submit clarification request in writing before installation. Otherwise, make changes in installed work required for compliance with manufacturer instructions or codes and standards within Contract Price.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, provide material, installation or work that is of the higher standard.

D. It is the requirement of these contract documents to require provision of systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In these cases, where notification required by Paragraph (A) above has not been submitted, provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed in accordance with the design intent.

E. In cases covered by Paragraph (D) above, where the contractor believes engineering guidance is needed, submit a sketch identifying proposed solution. College PM shall review, note if necessary, and approve the sketch.

F. Where discrepancies exist between the mechanical, plumbing, fire protection, and electrical drawings in regards to what trade owns equipment such as disconnects, starters, etc., the discrepancy shall be brought to the College Project Manager’s attention in accordance with paragraph (A) above. If the scope is not resolved prior to the Award of Contract, the Electrical Contractor shall provide such items.

G. Refer to Division 00 for additional requirements.

1.7 MODIFICATIONS IN LAYOUT

A. Drawings are diagrammatic. They indicate general arrangements of mechanical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet ceiling heights and other Architectural requirements.

B. In order to obtain the intended aesthetics in spaces used by building occupants, prior to installation of visible material and equipment (including access panels), review Architectural Drawings for desired locations and where not definitively indicated, request information from College PM.

C. Check Contract Drawings, as well as Shop Drawings, to verify and coordinate spaces in which work of this section will be installed.

D. Maintain maximum headroom at all locations. All piping, duct, conduit, and associated components to be as tight to underside of structure as possible.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades and to coordinate according to paragraphs above. Systems shall be run in a rectilinear fashion.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to College PM for review and approval. Refer to Division 00 for additional requirements.

1.8 REQUEST FOR INFORMATION (RFI'S)

A. Refer to Division 00.

1.9 RELATED WORK IN OTHER SECTIONS

A. The following work is not included and shall be performed under other Sections.

1. Excavation and backfill.
2. Concrete work, including concrete housekeeping pads and other pads and blocks for vibrating and rotating equipment, and cast in place manholes and handholes.
3. Cutting and patching of masonry, concrete, tile and other parts of structure, with the exception of drilling for hangers and providing holes and openings in metal decks.
4. Flashing of wall and roof penetrations.
5. Installation of access panels in floors, walls, furred spaces or above ceilings.
6. Painting, except as specified herein.
7. Structural supports necessary to distribute loading from equipment to roof or floor except as specified herein.
8. Temporary light, power, water, heat, gas and sanitary facilities for use during construction and testing.
9. Outdoor air intake and exhaust louvers.
10. Electric power wiring for all equipment shall be provided by Division 26, Electrical.
11. Installation of circuit breakers (furnished by ATC Contractor) and final electrical panel terminal connections for ATC control power wiring shall be provided by Division 26, Electrical.
12. Wall and ceiling enclosures and shafts for supply, return and exhaust ductwork as shown on drawings.

1.10 SITE VISIT

A. Refer to Division 00 for requirements.

1.11 EXISTING CONDITIONS AND PREPARATORY WORK

A. Refer to Division 00 for requirements.

1.12 CODES, STANDARDS, AUTHORITIES AND PERMITS

A. Perform work in accordance with rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have legal jurisdiction over the site.

B. Prior to work commencement of work, notify State and applicable authorities and submit all of the applicable notifications for construction, operation and/or demolition.

C. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:

1. Local and state building, plumbing, mechanical, electrical, fire and health department codes.
2. American Gas Association (AGA).
3. National Fire Protection Association (NFPA).
4. American Insurance Association (AIA) (formerly National Board of Fire Underwriters).
5. Occupational Safety and Health Act (OSHA).
6. Underwriters Laboratories (UL)
7. Factory Mutual Association (FM)
8. Owner's Insurance Underwriter.

D. Material and equipment shall be listed by Underwriters' Laboratories (UL), and approved by ASME, ANSI, ASTM, and AGA for intended service.

E. When requirements cited in this Specification conflict with each other or with Contract Documents, most stringent shall govern work. College PM may relax this requirement when relaxation does not violate ruling of authorities that have jurisdiction. Approval for relaxation shall be obtained in writing.

F. Unless indicated otherwise, the most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents.

1. American National Standards Institute (ANSI).
2. American Society of Mechanical Engineers (ASME).
3. National Electric Manufacturers Association (NEMA).
4. American Society for Testing and Materials (ASTM).
5. American Water Works Association (AWWA).
6. American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
7. Air Moving and Conditioning Association (AMCA).
8. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
9. Air Conditioning and Refrigeration Institute (ARI).
10. Thermal Insulation Manufacturers Association (TIMA).
11. Institute of Electrical and Electronics Engineers (IEEE).
12. Insulated Cable Engineers Association (ICEA).
13. Manufacturer's Standardization Society of the Valve & Fittings Industry (MSS)

G. Specific reference is made to the following NFPA standards which contain an exceptionally high quantity of mechanical, electrical, and fire protection requirements. These standards as referenced by the State Building Code shall apply in full.

1. No. 13 - Installation of Sprinkler Systems

2. No. 14 - Installation of Standpipe and Hose Systems
3. No. 20 - Installation of Centrifugal Fire Pumps
4. No. 30 - Combustible Liquids
5. No. 37 - Installation of Use of Stationary Combustion Engines and Gas Turbines
6. No. 45 - Fire Protection for Laboratories Using Chemicals
7. No. 70 - National Electric Code
8. No. 72 - National Fire Alarm Code
9. No. 101 - Life Safety Code

H. Secure and pay for all permits and inspections required by the Authorities having Jurisdiction. Secure trade permits prior to beginning work.

1.13 GUARANTEE AND 24 HOUR SERVICE

A. Guarantee the Work of this Section in writing for one year following the date of Substantial Completion. If the equipment is used for ventilation, temporary heat, or other use prior to initial beneficial occupancy by the Owner, the bid price shall include an extended period of warranty covering the one-year of beneficial occupancy by the Owner. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to Architect's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

B. In addition to guarantee requirements of Division 01 and of Paragraph A above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's name.

C. Replace material and equipment that require excessive service during guarantee period. Excessive service shall be defined as more than 3 service calls for the same material or equipment within a 12 month period.

D. Provide 24-hour service beginning on the date of Substantial Completion and lasting until the termination of the guarantee period. Service may be provided by a separate service organization subject to Owner approval. Submit name and a phone number that will be answered on a 24-hour basis each day of the week, for the duration of the service.

E. Submit copies of equipment and material warranties before final payment.

F. At end of guarantee period, transfer manufacturers' equipment and material warranties still in force to Owner.

G. This Paragraph shall not be interpreted to limit Owner's rights under applicable codes and laws and under this Contract.

H. Part 2 paragraphs of all specification Sections may specify warranty requirements that exceed those of this Paragraph.

I. Use of systems provided under this Section for temporary services and facilities shall NOT constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute guarantee period.

J. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise Architect in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Architect will suggest course of action.

1.14 COORDINATION DRAWINGS

A. A single set of coordination drawings shall be mutually prepared by all mechanical and electrical trades.

B. The initiation of these drawings begins with the Sheet Metal Subcontractor.

C. The Sheet Metal Subcontractor shall prepare a complete set of electronic type background drawings in approved versions of AutoCAD, REVIT, Navisworks, or approved alternative) at scale not less than 3/8" equals 1'-0" showing structure and other information as needed for coordination. Sheet metal layout including horizontal and vertical offsets and changes in direction and necessary access panels shall be shown thereon, as well as all fire walls and smoke partitions, which shall be shown in a different color than the regular partitions and the sheet metal. All trades shall electronically add their systems to the electronic formatted drawings, each trade in a different color. These electronic files will be considered the project Coordination Drawings. Drawing layers must coincide with original Vanderweil electronic format.

D. Each of the mechanical, electrical and other specialty trades shall add its work to these background drawings with appropriate offsets, elevations and grid dimensions, and showing necessary access panels. Specialty trade information is required for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers, and for spaces in and above ceilings where congestion of work may occur (e.g. corridors). This may apply to entire floors. Drawings shall indicate horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions, and other services.

E. Each specialty trade shall sign and date each plotted coordination drawing. Return drawings to the Sheet Metal Subcontractor, who shall route them sequentially to all specialty trades.

F. Where conflicts occur with placement of materials of various trades, the Sheet Metal Subcontractor will be responsible to coordinate the available space to accommodate all trades. Resulting adjustments shall be initialed and dated by the specialty trade. The Sheet Metal Subcontractor shall then final date and sign each drawing. If conflict cannot be resolved, the decision of the General Contractor/Construction Manager shall be final.

G. A Subcontractor who fails to promptly review and incorporate his work on the drawings shall assume full responsibility of installation conflicts affecting his work and of schedule ramifications.

H. Sheet Metal Subcontractor shall make copies of all coordination drawings for submission. Fabrication shall not start until copies of completed coordination drawings are received by the Architect and have been reviewed.

I. Review by Engineer of coordination drawings is limited to confirming that requirements for coordination and preparation of plans have been complied with by the Construction Manager or General Contractor and shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with Architectural, Structural, Mechanical, Electrical and other related work.

J. After Review:

1. After review of coordination drawings, the method used to resolve interferences not previously identified shall be as described in Paragraph 1.07 "MODIFICATIONS IN LAYOUT" above.

2. All changes to reviewed coordination drawings shall be in writing by the Architect prior to start of work in affected area.

K. Distribution of Reviewed Coordination Drawings:

1. The Sheet Metal Subcontractor shall provide one color coded electronic copy and one color coded hard copy of the reviewed Coordination Drawings to each of the specialty trades, the Contractor and the Owner..

L. The main paths of egress and for equipment removal, from main mechanical and electrical rooms shall be clearly shown on the coordination drawings.

M. Coordination Drawings shall include, but are not limited to:

1. Plumbing systems, piping and equipment.
2. HVAC piping, systems and equipment.
3. Control systems.
4. Electrical distribution, systems and equipment.
5. Lighting systems and fixtures.
6. Sheet metal work, components and accessories (e.g. coils, terminal boxes).
7. Fire protection and sprinkler system, piping and heads.
8. Structural.
9. Electrical Equipment Room layouts.
10. Environmental Rooms and associated refrigeration/heating systems.
11. Partition/room layout.
12. Ceiling tile and grid
13. Access panels.
14. Smoke and fire dampers.
15. Roof drain piping.
16. Major electrical conduit runs, panel boards, feeder conduit and racks of branch conduit.
17. Above ceiling miscellaneous metal.
18. Heat tracing of piping.

1.15 SHOP DRAWING SUBMITTALS

A. This Paragraph supplements Division 01.

B. Definitions:

1. Shop Drawings are information prepared to illustrate portions of the work in more detail than shown in the Contract Documents.

2. Coordination Drawings are detailed, large-scale layout Shop Drawings showing HVAC, Electrical, Plumbing and Fire Protection work superimposed in order to identify conflicts and ensure inter-coordination of Mechanical, Electrical, Plumbing, Architectural, Structural and other work.

3. Electronic Copy means copy in a searchable PDF format, and excludes scanned material and faxed material. Scanned material and faxed material shall not be submitted.

4. Shop drawings shall be submitted with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.

C. Submittal Procedures and Format

1. Construction Manager or General Contractor shall review submittal packages for compliance with Contract Documents and then submit for review by Architect. Review by Construction Manager or Contractor is intended to ensure that the submittals include the foregoing cover sheet, are in the correct electronic or paper format as specified below, and that the item fits into the space provided. Also, that the submittal contains adequate information to verify specification requirements as well as the performance and dimensional requirements shown on the drawings. If a shop drawing is returned with a submittal status of "REJECTED" or "REVISE AND RESUBMIT", it indicates the shop drawing was not adequately reviewed by the Contractor. Subsequent submittals shall include a written response to previous items.

2. Submittal Contents

   a. Submittals shall be comprehensive and fully self contained.

   b. Electronic submittals shall be fully self contained and shall not contain links to associated websites.

   c. Submittals shall include all catalog data and physical and performance characteristics and plans and diagrams as necessary to confirm compliance with plans and specifications.

   d. Submittals shall contain only information relevant to the particular equipment or materials to be furnished. Clearly indicate the piece of equipment or material being provided. Do not submit generic catalog cuts which describe several different items in addition to those specific items being provided, unless all irrelevant information is marked out or relevant information is clearly differentiated. Those features that are not being proposed for this project shall be crossed out so as not to imply that they are included.

3. Division 23 shop drawings and installation layout drawings for heating, pumping, process piping, and refrigeration systems prepared by the Installer shall note name(s), license number(s), and license expiration dates of the installing firm.

4. Submit the following for review with submittal cover sheet for each product:

   a. Electronic copy (see above definition of electronic copy) with cover sheet for each shop drawing, except those noted below.

   b. Electronic copy with cover sheet, plus one paper copy by overnight mail, for the following submittals:

      1) Air handling unit

      2) Chiller

      3) Cooling Tower

      4) Boiler

      5) Electrical switchgear and generator

      6) Electrical short circuit, coordination, and arc flash studies

      7) Lighting

      8) Fire protection calculations

      9) Other submittals if larger than 8-1/2x11

   c. Electronic copy with cover sheet plus one paper copy in 11x17 format with cover sheet, by overnight mail for all controls submittals.

d. Sheet Metal Shop Drawings

1) Provide electronic copy, containing sufficient plans, elevations, sections, details and schematics to describe work clearly. Plans shall be ⅜" = 1'-0" scale and shall indicate work of other Sections where physical clearances are critical and where interferences are possible. Provide larger scale details to show complete installation. Sheet metal drawings shall show elements of Architect's reflected ceiling plan, exposed ductwork, walls, partitions, diffusers, registers, grilles, fire dampers, sleeves and other aspects of construction for coordination.

5. After review, Contractor to receive electronically transmitted response report for all reviewed submittals which includes the following information:

a. Submittal status

b. List of reviewer's comments

c. Copy of returned submittal. All submittals will be returned electronically, with the exception of coordination drawings, which will have one copy returned with comments through overnight mail.

6. Shop drawings showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

7. Provide shop drawing submittals showing details of piping connections to ALL equipment. If connection details are not submitted and connections are installed incorrectly in the field, reinstall within the original contract price.

D. Acceptable Manufacturers: The Architect's mechanical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers may be listed as being acceptable. These are acceptable only if, as a minimum, they:

1. Meet all performance criteria listed in the schedules and outlined in the specification. For example, to be acceptable, an air handling unit must deliver equal CFM against equal external static pressure using equal or less horsepower as the air handler listed in the schedules.

2. Have identical operating characteristics to those called for in the specification. For example, a reciprocating compressor will not be acceptable if a rotary model is specified.

3. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Architect has determined that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.

4. For rooftop mounted equipment and for equipment mounted in areas where structural matters are a consideration, the products must have a weight no greater than the product listed in the schedules or specifications.

5. Products must adhere to all architectural considerations including, but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.

E. Required Use of Acceptable Manufacturers on this Project:

1. Substitution of products other than those of the Acceptable Manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified Alternate Manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.

F. Deviations

1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of Shop Drawings which flags the deviation to the attention of the Architect.

2. Without letters flagging the deviation to the Architect, it is possible that the Architect may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Architect, the contractor shall hold the Architect and his consultants harmless for any and all adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Architect has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.

3. Approval of proposed deviations, if any, will be made at discretion of Architect.

G. Submittal Status: Electronic and paper submittals will be returned notated as illustrated below:

"REVIEWED"

"Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with."

"REVIEWED, DEVIATIONS NOTED; REVISE AND RESUBMIT"

"Submittal contains deviations which shall be corrected and confirmed by a new submittal."

"REJECTED"
Submittal is incorrect to such an extent that material is unacceptable, or is incomplete to such an extent that a complete review cannot be made. Resubmit in accordance with requirements of the Contract Documents."

"NO ACTION"
Submittal not reviewed.

H. Responsibility

1. Intent of Architect's submittal review is to check for capacity, rating, and certain construction features. Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this and other Sections. Work shall comply with submittals marked "REVIEWED" to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. Noting of some errors while overlooking others will not excuse proceeding in error. Contract Documents requirements are not limited, waived nor superseded by review.

2. INFORM SUBCONTRACTORS, MANUFACTURERS AND SUPPLIERS OF SCOPE AND LIMITED NATURE OF REVIEW PROCESS AND ENFORCE COMPLIANCE WITH CONTRACT DOCUMENTS.

I. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. Contractor shall assume full responsibility for delays caused by not incorporating the following shop drawing review time requirements into his project schedule. Working days listed reference the time in the Engineer's office. It does not include transmittal or review time of others. Allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that 20 working days, exclusive of transmittal time, are required for the following:

1. HVAC temperature control submittals.
2. HVAC balancing report.
3. Coordination Drawings.
4. Fire protection fabrication drawings.
5. If more than five shop drawings of a single trade are received in one calendar week.

J. List of Proposed Equipment and Materials

1. Within four weeks after Award of Contract and before ordering materials or equipment, submit complete list of proposed materials and equipment and indicate manufacturer's names and addresses. No consideration will be given to partial lists submitted out of sequence.

1.16 RECORD DRAWINGS

A. This paragraph supplements Division 01.

B. As work progresses and for duration of Contract, maintain complete and separate set of prints of Contract Drawings at job site at all times. Record work completed and all changes from original Contract Drawings. Such changes shall include, but not be limited to, those resulting from RFI's, field conditions, and modifications and additions. Include actual location of existing utilities if they differ from design documents. Record valve tags as they are installed. In addition, take photographs of all concealed equipment in gypsum board ceilings, shafts, underground (buried) piping routes and supports and other concealed, inaccessible work. At completion of work, make copies of photographs with written explanation on back. These shall become part of Record Documents.

C. Underground and utility work shall be located by distances to landmarks, such as building foundations. Give actual dimensions of everything installed including elevations and elevations at each change in direction.

D. Drawings shall show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation.

E. "Record Drawings" are a complete set of drawings containing the information in (A) - (D) above.

F. The installing Contractor shall certify Record Drawings for accuracy. The Architect/Engineer will not certify the accuracy of the record drawings - this is the sole responsibility of the Contractor.

G. The installing contractor shall configure the drawing layers to be the same as those in Vanderweil Engineers' format.

H. If required by the Authority having jurisdiction, each trade shall submit a set of record drawings for approval by the Authority. Format for submission shall be acceptable to the Authority. Drawing format

and size changes, and supplemental information required for the submittal are the responsibility of the installing contractor. Provide copies of submittal to General Contractor, Owner, Architect, and Engineer.

I. At completion of work, prepare a complete set of record drawings in electronic format. Deliver these to the College PM for approval.

J. After approval, deliver the following:

1. Original (not scanned) electronic version of drawings in approved format, notated as "Record Drawings," and conformed to incorporate all changes to the original design noted above. The changes shall be clouded and appropriately identified. Deliver one copy each to the General Contractor, Owner, Architect, and Engineer.
2. Deliver to the Owner one set of blackline record drawings stamped "record" and signed by the appropriate subcontractors.
3. Electronic version of contract specifications with addenda incorporated, will be provided by Vanderweil as the Record Specifications.

K. Smart Record Drawings

1. Contractor shall import the conformed and approved final record drawings into Navisworks and establish electronic hyperlinks. The final work product shall be a self-contained compact disk containing the record drawings in Navisworks with the below-described hyperlinks to PDFs of the hyperlinked information, also contained on the disk. The disk shall also contain the full MEP specifications in secure searchable PDF format.
2. Electronic hyperlinks shall be established so that when any scheduled equipment is clicked on in plan view or sectional view, or on the schedules, the following menu of hyperlinks will appear:

<u>If Clicking on Plan or Section</u>
Hyperlink to PDF of Schedule for That Item
Hyperlink to PDF of Shop Drawing for That Item
Hyperlink to PDF of Corresponding Section of Maintenance Manual
Hyperlink to PDF of Corresponding Section of Manufacturers Catalog
Hyperlink to PDF of Specification for That Item
<u>If Clicking on Schedule</u>
Hyperlink to PDF of Shop Drawing for That Item
Hyperlink to PDF of Corresponding Section of Maintenance Manual
Hyperlink to PDF of Corresponding Section of Manufacturers Catalog
Hyperlink to PDF of Specification for That Item

3. By clicking on any menu selection, the respective electronic hyperlink shall be established.
4. If the same component is used numerous times throughout the project, each of which is described by the same shop drawing submittal, maintenance instructions, specification section, and manufacturer's catalog sheet, it is not required to link each and every installation of that component. Instead, Contractor shall hyperlink one or more prototypical installations. Examples where this approach is applicable are: VAV boxes, valves, and circuit breakers 480V or less.
5. All hyperlinked equipment and components shall be color coded in the same unique color, that stands out from other colors in use.
6. This requires importation of PDFs of the catalog information into Navisworks from the manufacturer's websites, importation of PDFs of the relevant section of the Maintenance Manual, etc.

7. Once all the necessary hyperlinks have been established and the hyperlinked material has been imported, and the Smart Drawings have been proved operational, download the completed package onto self-contained CDs and distribute to Construction Manager or General Contractor, as well as Owner, Architect, Engineer.

8. Deliver to the Owner one set of blackline record drawings stamped “record” and signed by the appropriate subcontractor.

9. Electronic version of contract specifications with addenda incorporated, will be provided by Vanderweil as the Record Specifications.

1.17 BULLETINS, MANUALS, AND OPERATING INSTRUCTIONS - ELECTRONIC FORMAT

A. This paragraph supplements Division 01.

B. “Electronic Format” means searchable PDF format. It does not include scanned items, which are considered inappropriate.

C. Obtain at time of purchase of equipment, electronically formatted versions of operation, lubrication and maintenance manuals for all items. Assemble this literature along with other information in coordinated electronic manuals with additional information describing combined operation of field assembled units, including as-built wiring diagrams. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment. Divide manuals into three sections or books as follows:

1. Engineering flow diagrams and controls sequences from project mechanical drawings, approved automatic temperature controls submittal, equipment startup procedures and operational instructions. Startup and operational instructions shall list valves, switches, and other devices used to start, stop and control systems. Describe procedure to be followed in case of malfunctions. Include approved valve directory showing each valve number, location of each valve, and equipment or fixture controlled by valve.

2. Detailed maintenance and troubleshooting manuals containing data furnished by manufacturer for complete maintenance. Include copy of balancing report.

3. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment. Include additional instructions necessary for implementation of first class lubrication program. Include approved summary of lubrication instructions in chart form, where appropriate.

D. Submit electronic format version of manual(s) to College PM for approval. After approval, submit electronic version and one hard copy for Architect’s distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

E. Operating instructions: Upon completion of installation, prior to Owner accepting portions of building and equipment for operational use, instruct Owner's operating personnel in operation of systems and equipment. Instruction shall be performed by equipment and controls vendors’ factory-trained personnel. Owner shall determine which systems require additional instruction. Duration of instructions for controls shall take equipment through complete cycle of operation (at least five working days). Make adjustments under operating conditions.

PART 2 - PRODUCTS (THIS PART NOT USED)

PART 3 - EXECUTION

3.1 LIFE SAFETY SYSTEMS CERTIFICATION OF COMPLETION

A. Definitions

1. Life Safety Systems - Mechanical and electrical systems including:
    a. Fire Suppression Systems
    b. Fire Notification (Alarm) and Detection Systems
    c. Smoke Exhaust and Control Systems
    d. Egress Signage and Lighting Systems
    e. Emergency Power Systems
2. Complete - For a system to be complete the following shall be true:
    a. No further work is required to satisfy the requirements specified in the drawings, specifications and applicable codes and standards.
    b. Systems are fully operational with power to components, valves open, status indicators in "normal" condition and otherwise ready "as-is" to perform required functions.
    c. Required product data and shop drawing submittals have been submitted and returned with a "Reviewed" status. See Paragraph 1.17 “Submittals” for submittal requirements.
    d. Test certificates have been submitted and returned with a "Reviewed" status. See Paragraph 1.17 “Submittals”.
    e. Project visit report observations and "punch list" items have been addressed and/or corrected.
    f. "O&M" documentation and "as-built" plans have been submitted and returned with a "Reviewed" status.

B. Notification of Completion

1. Notify the College PM in writing that the life safety systems are complete at least five (5) working days prior to requesting final certification of completion ("affidavits") from the Architect. The notification shall be in the form of a single formal document endorsed by an individual charged with management responsibility for all trades associated with the life safety systems.
2. Schedule work so life safety systems are complete in advance of other systems. This requirement is to allow the Architect to conduct a final project visit and correction of issues found without affecting issuance of a Certificate of Occupancy by the Authorities Having Jurisdiction.

3.2 SPECIAL RESPONSIBILITIES

A. Cooperate and coordinate with work of other Sections in executing work of this Section.

1. Perform work so that progress of entire project including work of other Sections shall not be interfered with or delayed.
2. Provide information as requested on items furnished under one Section which shall be installed under other Sections.

3. For equipment provided under any division or section which has connection made under the mechanical or electrical sections, obtain detailed installation and hookup information from the equipment manufacturers.

4. Obtain final roughing dimensions or other information as needed for complete installation of items furnished under other Sections or by Owner.

5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under all Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information in proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Architect.

6. Provide information as requested as to sizes, number and locations of concrete housekeeping pads necessary for floor-mounted vibrating and rotating equipment provided under this Section.

7. Notify Architect of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Architect, relocate piping, ductwork and equipment to permit new work to be provided. Remove non-functioning and abandoned piping, ductwork and equipment. Dispose of or store items.

B. Building Expansion Joints and Firewalls

1. Ductwork, conduit, cable tray, piping, and other horizontal distribution systems shall be provided with approved expansion provisions when passing by building expansion joints. Provide copper ground jumper across expansion joints for electrical components. Systems shall be run through rated walls, partitions, and floors via approved fireproofed sleeves.

C. Installation Shall Provide Access to Systems

1. Installation shall allow clearances for easy access to systems for routine maintenance, for repairs, and for installing new cable in conduit and cable trays.

2. Access panels shall be installed in ceilings that are not composed of removable tiles. These shall be located wherever systems components exist that have moving parts, motors, or other components requiring periodic maintenance, adjustment, or replacement. Access panels shall be shown on Coordination Drawings and shall be of the type and finish as approved by the Architect.

D. Protection of Work

1. Each contractor shall be responsible for work and equipment until finally inspected, tested, and accepted. Carefully store materials and equipment that is not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material. Cover work subject to falling debris with temporary covers.

2. Provide all materials, equipment and labor to provide adequate protection of all equipment during the course of construction. This includes protection from moisture and foreign material. At completion, all work must be turned over to Owner clean and in new condition.

3. Protect the work and material of other trades that might be damaged by work or workmen and make good all damage thus caused.

E. Installation Only Items

1. Where it is required install items that it does not purchase, coordinate the delivery and be responsible for their unloading from delivery vehicles and for safe handling and field storage up to the time of installation.

a. Necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.

b. Their connection to building systems including the purchase and installation of terminating fittings necessary to adapt and connect them to the building systems.

2. Carefully examine items upon delivery. Claims that these items have been received in a condition that their installation will require procedures beyond the reasonable scope of work of this contract will be considered only if presented in writing within one week of their date of delivery. Unless claims have been submitted, fully recondition or replace damaged items.

F. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions. Protect work and equipment from damage and exposure to moisture and outdoor extreme temperature conditions until finally inspected, tested, and accepted. Carefully store materials and equipment that is not immediately installed after delivery to site. Close open ends of work including piping and ductwork with temporary covers or plugs during construction to prevent entry of obstructing material or debris.

G. Use of premises shall be restricted as follows:

1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of Architect.

2. Store materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.

3. Do not interfere with function of existing sewers and water and gas mains, electrical, or mechanical systems and services. Extreme care shall be observed to prevent debris from entering pipe, ductwork and equipment. Confer with College PM as to disruption of services or other utilities due to testing or connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation. Obtain Owner's approval of the method proposed for minimizing service interruption.

H. Surveys and Measurements:

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct lay out of work.

2. In event of discrepancy between actual measurements and those indicated, notify College PM in writing and do not proceed with work until written instructions have been issued.

I. Fireproofing:

1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.

2. Ducts, piping and other items that would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.

3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for an extra to Owner.

J. Temporary Utilities:

1. Refer to Division 1 regarding requirements.

2. Coordinate work under this Section with progress of construction so that permanent heating system will be ready to provide temporary heating if permitted by College PM as soon as building is closed in.

3. Provide and direct labor required for attendance, operation and final restoration of permanent heating system if used for temporary heating purposes. Continuous direct attendance shall be provided whenever permanent system is in operation prior to acceptance of permanent heating system by Owner.

K. Airbound Systems

1. If, after plant is in operation, piping systems, coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be repiped with new approved and necessary fittings, air vents, or vacuum breakers at no extra cost. If connections are concealed in furring, floors, or ceilings, this trade shall bear all expenses of tearing up and refinishing construction and finish, leaving same in as good condition as before it was disturbed.

L. Miscellaneous

1. Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving equipment on and around site, in building or on roof.

3.3 CONTINUITY OF SERVICES

A. Do not interrupt existing services without College PM's approval.

B. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.

C. Interruptions shall be scheduled at times of day and work so that they have minimal impact on Owner's operations.

D. Subcontractor shall coordinate shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days are required.

2. Minimize shutdowns.

3. Provide temporary services where required and perform shutdowns and tie ins at a time convenient to Owner.

4. Subcontractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.

5. Perform required survey and inspection work required by the notice for shutdown.

E. Include premium time work associated with interruptions of services and/or shutdowns to avoid disruption to Owner's operations.

3.4 CLEANING

A. Cleaning shall be performed prior to commissioning.

B. Ductwork

1. Ducts shall be thoroughly cleaned so that no dirt or dust shall be discharged from diffusers, registers or grilles, when system is operated.

2. Provide temporary connections required for cleaning. Provide cheesecloth for openings during cleaning.

3. Replace filters prior to final inspection and testing.

C. Piping

1. Furnish pipe cleaning chemicals, chemical feed equipment, materials and labor necessary to clean piping.

2. Permanently install necessary chemical injection fittings complete with stop valves.

3. After piping systems have been pressure tested and approved for tightness, clean and flush piping as specified and in accordance with applicable codes.

4. Maintain continuous blowdown and make-up during flushing operation.

D. Equipment

1. After completion of project, clean the exterior surface of equipment, including concrete residue, dirt and paint residue.

3.5 PROJECT PUNCH LIST PROCEDURE

A. When the contract work is substantially complete, each trade contractor shall physically walk down the installation and prepare a punchlist containing an itemization of work remaining for 100% completion. The punchlist shall be submitted to the College PM as a prerequisite to the Architect's own punchlist, which will then be developed to complement that of the trade contractor.

B. If, when the Engineer arrives at the site certain areas are not complete and ready for punch out, the Engineer will not review these areas. When a second notification is issued indicating the installation is completed and the Contractor has punched and corrected these areas, the Engineer will then re-visit the site for final observations and punch list.

3.6 FUNDAMENTAL COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. Refer to Division 01 for commissioning regarding additional submittal, quality assurance, and product requirements. Coordinate startup, checkout and testing procedures with the aforementioned specification. General contractor and subcontractors are responsible for reviewing, supporting and executing commissioning requirements as defined by this specification.

B. General

1. Completion of start up and commissioning shall be accomplished as a prerequisite for substantial completion.

2. Operate and maintain systems and equipment until final acceptance by the Owner.

3. All guarantees and warranties shall not begin until final acceptance of the systems and equipment by the Owner. Acceptance requires, at a minimum, completed systems commissioning.

4. The Owner maintains the right to have access to the entire project site to develop his own operational procedures.

5. The following shall be commissioned: HVAC Systems and Equipment, Plumbing Domestic Hot Water System, Laboratory Lab Gas systems, Laboratory and Water System, Electrical Lighting Controls System.

C. Commissioning Team

1. The commissioning team shall consist of: (a) the Contractor's Commissioning Project Manager ("CxPM"), plus the Project Manager for the controls vender, plus designated representatives of piping, sheetmetal, electrical, and plumbing subcontractors; (b) the Commissioning Authority ("CxA"), (c) a representative of the Owner, (d) if the HVAC engineer is not providing the CxA, then a representative of the HVAC engineer will be on the commissioning team.

2. The CxPM shall be assigned by the Construction Manager and shall be an employee of the Construction Manager, or, if there is no Construction Manager, then the CxPM shall be assigned by the General Contractor and shall be an employee of the General Contractor.

3. The CxPM shall serve as the construction team's single point of contact for the CxA. The CxPM shall be responsible for Contractor oversight and direction of the commissioning effort and for communications to all contractors' and subcontractors' representatives on the commissioning team. It shall be the CxPM's responsibility to ensure that all required parties, including technical representatives of equipment vendors, are present at commissioning related effort when required by this specification and/or when requested by the CxA. The CxPM shall witness all commissioning activities and shall initial commissioning forms to indicate satisfactory completion.

4. During the course of construction, in advance of pre-inspection and functional performance testing, the commissioning team shall meet periodically to plan the commissioning effort. Quantity and frequency of meetings shall be determined by the CxA, and will not exceed a total of four.

D. Contractor's Responsibilities

1. The Contractor shall perform the commissioning.

2. Commissioning includes all meetings, planning, scheduling, coordination, inspection testing, adjustment, re-testing, and material and labor necessary to ensure that all commissioned systems operate according to the Construction Documents.

3. The phases and overall scope of commissioning are as follows:

   a. Planning. Meeting, scheduling, and coordination to ensure that all parties, including vendors' representatives, know in advance the scope and schedule of what is required of them in the commissioning process.

   b. Commissioning Pre-Inspection (CPI). After equipment is installed, connected, and ready to operate, but before balancing and functional performance testing, the Contractor shall conduct pre-inspection to validate the installation of all equipment being commissioned. This shall be done in accordance with the pre-inspection forms (CPI forms) included in this section of the specification. The CxPM and the respective contractor's commissioning team member shall witness and shall certify the results of the pre-inspection by initialing the respective forms. The CxPM shall advise the CxA of the exact schedule for pre-inspection so that the CxA can witness parts or all of the pre-inspection. A representative of the electrical subcontractor shall be present throughout the CPI process to confirm electrical connections. A representative of the ATC subcontractor shall be present throughout the CPI process to confirm controls connections.

   c. Equipment Startup. After pre-inspection is complete, equipment shall be systematically started up according to the schedule approved by the CxPM and the commissioning team.

Representatives of equipment vendors shall be present to observe and to assist in the startup process.

d. After equipment has been successfully started up and operated, systems shall be tested and balanced. Testing shall include testing and verification of all controls sequences.

e. Functional Performance Tests (FPT). After systems are complete and equipment pre-inspection, startup, and testing and balancing have been completed, contractor shall conduct functional performance testing, in order to validate component and systems performance. This shall be done in accordance with the functional performance testing forms (FPT forms) included in this section of the specifications. The CxPM and the respective contractor's commissioning team members shall witness and shall certify the results by initialing the respective forms. The CxPM shall ensure that representatives of equipment vendors are present to observe and assist in the testing of respective equipment. The CxPM shall advise the CxA of the exact schedule for functional performance testing so that the CxA can witness parts or all of it. The functional performance tests shall be conducted over a continuous nominal one-month period in which the CxPM, and the controls project manager and controls technicians shall be constantly present and available, and the CxA shall be present periodically (on a discretionary basis). The continuous nominal one-month functional performance test period is a nominal duration only. The actual duration may be more or less than one month, but the commissioning effort shall be continuous day to day for whatever duration is required to complete it, and the CxPM, the controls project manager, and the controls technicians shall be constantly present and available.

f. Acceptance of Installation and Closeout

1) Acceptance and closeout shall be accomplished when the following has been satisfactorily completed by the contractor and certified by the CxA:

a) Pre-inspection

b) Startup, testing, and balancing

c) Functional Performance Testing

d) Systems Operating and Maintenance Manual

e) Warranties and 24 hour Service Phone Number Received

f) Other requirements of Paragraph 3.7 "Project Closeout Procedure"

3.7 COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. General

1. Completion of start up and commissioning shall be accomplished as a prerequisite for substantial completion.

2. Operate and maintain systems and equipment until final acceptance by the Owner.

3. All guarantees and warranties shall not begin until final acceptance of the systems and equipment by the Owner. Acceptance requires, at a minimum, complete systems commissioning.

4. The Owner maintains the right to have access to the entire project site to develop his own operational procedures.

B. Comprehensive Work Plan & Reporting

1. Provide detailed, methodical, scheduled, start up and commissioning procedures and execution of same for every system and piece of equipment provided.

2. Attend start up and commissioning meetings on a regular basis.

3. Develop and provide a written work plan with detailed procedures for this work and submit, using shop drawing submittal procedure, within 3 months of the contract award. The work plan shall include provisions for an integrated start up plan and schedule. The plan and schedule shall identify tasks, start and completion dates, critical path items, interface requirements with other trades and major equipment start up, as minimum requirements of the plan.

4. The purpose of this work plan is to provide for smooth, quick, and efficient start up and commissioning of systems and equipment and to provide for a smooth transition to turn the complete, correctly operating building over to the Owner.

5. The Owner and Architect will have input to and be part of the approval process for the start up and commissioning plan.

6. Develop and submit for approval a specific start up, check out and sign off form for each and every system.

7. Develop and submit for approval a specific start up, check out and sign off form for every piece of major equipment.

8. Systems shall be operated under actual or simulated full load conditions. Identify the operating conditions in the work plan.

9. Work plan shall incorporate the "Demonstration of Successful Operation" described below.

10. The Architect/Owner may check the completed and commissioned installation either sequentially as different parts are completed, and/or when the entire installation is complete, at the sole option of the Architect/Owner.

11. Each trade shall arrange that an officer of the contracting company shall certify that each and every system has been tested. At the conclusion of the tests, submit a letter and enclosed commissioning forms signed by the officer stating:

    a. That he/she is an officer of the company.

    b. That he/she certifies that the specified testing of the systems has been performed by the company (give the name and dates of system testing).

    c. The results of the testing, as compared to specified performance, listing the name, title, and company affiliation of all those witnessing and performing these tests.

C. Commissioning

1. Commission equipment and systems in accordance with the approved work plan, completing the start up, check out and sign off forms for each piece of equipment and each system.

2. Provide qualified personnel, equipment, apparatus and services for start-up and testing of equipment and systems, to obtain the performance data shown in schedules, as specified or shown in commissioning forms in compliance with applicable codes, standards, regulations and authorities having jurisdiction including Municipal Inspectors, Owners and Architect.

3. Start up and testing procedures as may be outlined in the various sections of the specifications are the minimum effort required for the project. Use additional procedures required to properly start up and test the systems and equipment actually installed on the job.

4. Prove capacity and performance of equipment by field testing. Install thermowells and gauge connections and at no additional cost to Owner equipment and instruments required for testing.

5. Qualified representative of equipment manufacturer shall be present at test.

6. For each piece of equipment, copy nameplate data and include with the letter and start up, check out and sign off forms referred to above.

7. Do not cover or conceal work before testing and inspection and obtaining approval.

8. Leaks, damage and defects discovered or resulting from start up and testing shall be repaired or replaced by this contract to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.

D. Demonstration of Successful Operation

1. After components and systems have been commissioned, provide a 2 week, 24 hour per day fully functional automatic operation period of systems simultaneously. This shall be successfully concluded before systems are accepted by Owner.

3.8 PROJECT CLOSE-OUT PROCEDURE

A. General

1. The requirements of this section are in addition to and supplement the requirements outlined in Division 01, Execution and Closeout Requirements.

2. Hand-deliver project close-out checklist items and to obtain authorized signed receipt for items requiring Owner sign-off.

B. Project Close-Out Checklist

1. Review requirements of each section of the specifications and submit for approval to Architect the sign-off forms that shall become the project close-out checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Architect and/or Owner may incorporate additional specific items to the following checklist which shall become part of the project requirements.

2. Close-Out Checklist Example.

PROJECT CLOSE-OUT				
PROJECT:				
DIVISION NO.:				
CONTRACTOR:				

ITEM[1]	DATES		OWNER'S SIGN-OFF
	COMPLETED	RECEIVED BY OWNER	
Permits			
City and County Inspection			
Manufacturer's Warranties			
Contractor's Warranties			
State Fire Rating Data			
Copy of Final Shop Drawings			
List and Possession of Spare Parts			
Pressure Tests			
Equipment Tests Required by Specs			
O & M Manuals			
Record Documents			
Coordination Drawings			
Sanitization Reports			
Commissioning Reports/Letters/Forms			
On Site Training Complete			
Protective Device Settings			
Valve Tags and Charts			
Final ATC Installation Drawings			
Insurance Underwriters Approvals			
Final Punch List (Initialed by contractor that items are complete)			
Building Certificate of Occupancy (CO)			
24 Hour Phone No. for Service During Guarantee Period			

END OF SECTION

END OF SECTION

N:\N0912.00\DOC\SPEC\2012_03-16_BID\200000_MECH_ELEC REQUIREMENTS_.DOC

[1] Provide separate line item for each specified item (do not group items)

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Mechanical sleeve seals.
   3. Sleeves.
   4. Escutcheons.
   5. Grout.
   6. Fire-suppression equipment.
   7. Equipment installation requirements common to equipment sections.
   8. Painting and finishing.
   9. Concrete bases.

B. Refer to Section 220529 for pipe supports and hangers.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Mechanical sleeve seals.
   2. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: **EPDM** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

L. Sleeves are not required for core-drilled holes.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
    b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
    c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
        1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.5 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 210500

SECTION 210800 – FIRE SUPPRESSION SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment testing and start-up

B. Validation of proper and thorough installation of Division 21 systems and equipment

C. Equipment performance verification

D. Functional testing of Fire Protection systems

E. Documentation of tests, procedures, and installations

F. Coordination of training

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) is retained by the Owner shall work with the Contractor and the Design Engineer to direct and oversee the Cx process and perform functional performance testing.

C. This Section outlines the Cx procedures specific to the Division 21 Contractors. Requirements common to all Sections are specified in Sections 019113 and 019114 and the Cx Plan.

1.3 SCOPE

A. The following are included in the Scope of Commissioning on this project:

1. Fire Suppression Systems and Controls
2. Fire Pumps

1.4 RELATED WORK AND DOCUMENTS

A. Commissioning Plan: The Commissioning Plan outlines the commissioning process beyond the construction specification. All Contractor responsibilities are outlined in Specifications. Cx Plan is available to the Contractor to understand the context of their responsibilities but does not define any additional responsibilities of the Contractor

B. Section 019113 – General Commissioning Requirements: details the Cx requirements common across all divisions

C. Section 019114 – Functional Testing Procedures: Outlines the generic functional testing procedures required.

D. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

E. Section 220800– Plumbing Systems Commissioning: Details the commissioning procedures specific to Plumbing Systems (Div 22) work.

F. Section 230800 – HVAC Systems Commissioning: Details the commissioning procedures specific to HVAC (Div 23) work.

G. Section 230995 – Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.

H. Section 260800 – Electrical Systems Commissioning: Details the commissioning procedures specific to Division 26 work.

I. Section 280810 – Security Systems Commissioning: Details the commissioning procedures specific to the Security System.

J. Section 280820 – Fire Alarm Systems Commissioning: Details the commissioning procedures specific to the Fire Alarm System.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113

1.6 REFERENCE STANDARDS

A. Local Building Codes

B. National Fire Protection Association (NFPA)

C. National Electric Code (NEC)

D. American Society for Testing and Materials (ASTM)

E. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

F. Illuminating Engineering Society (IES)

G. Institute of Electrical and Electronics Engineers (IEEE)

H. International Electrical Testing Association (NETA)

I. National Electrical Manufacturer Association (NEMA)

J. Underwriters Laboratory, Inc. (UL)

1.7 DOCUMENTATION

A. In addition to the documentation required in Section 019113, Contractor shall provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format. These may include but are not limited to:

   a. Fire pump certified curves

2. Field Testing Agency Reports: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Provide in acceptable electronic format. These may include but are not limited to:

   a. Hydraulic Test for the Fire Pump
   b. Testing of the Fire Pump Transfer Switch

3. Fire alarm system approvals and certifications

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 21.

B. Construction Phase

1. Coordinate the work of the Fire Pump Testing Agency and the Cx requirements.
2. Coordinate the checkout of the fire suppression system and the approval of the regulatory authorities with the Cx process.

1.9 INDEPENDENT FIRE PUMP TESTING AGENCY

A. An independent testing agency shall be provided under the construction specifications and therefore included with the bid. Many of the aspects of the start up and functional performance testing indicated herein will be accomplished under the respective section and witnessed by the CxT at the indicated sample rate. CxT will include applicable test results in the functional performance testing record.

1. Fire Pump Controller and Transfer switch operation testing documentation shall be included.

1.10 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 START-UP PROCEDURES - GENERAL

A. Part 3 of this Section outlines specific start-up, check out and training requirements for systems and equipment. These requirements along with those specified in the individual section provide a minimum or guideline for development of start-up procedures, checklists and tests. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized Start-Up Procedures specific to the equipment and systems installed on this project.

B. Coordination with other contractors: Division 21 contractor shall coordinate with the mechanical contractors for testing of mechanical components, fire alarm contractor for checkout of alarming of the suppression systems and electrical contractor for testing of electrical components.

3.2 METERS AND GAGES

A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Adjust faces of meters and gages to proper angle for best visibility.
2. Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gages requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
3. Meters and gages requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.3 PIPING - GENERAL

A. Start-Up Checks: These Procedures apply to all installed piping systems, including underground site utilities.

1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
2. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
3. Ensure adequate drainage is provided at low points and venting is provided at high points.
4. Ensure air is thoroughly removed from the system as applicable. Ensure facilities to effectively drain and fill the system are in place.
5. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
6. Provide notification of pressure testing
7. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
8. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
9. Submit pressure test reports that document the pressure testing results with Certification of the results.
10. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
11. Set and adjust fill, pressure, or level controls to the required setting.

3.4 AC MOTORS

A. Start-Up Checks: Follow the manufacturer's written procedures and the following as a minimum:

1. Inspect terminations and grounding
2. Ensure proper access to all electrical equipment
3. Ensure proper labeling of all electrical equipment
4. Compare wiring of poles to manufacturer's instructions
5. Verify proper alignment, installation, and rotation
6. Check voltage to disconnects with disconnect open and compare to rating data.
7. In collaboration with the contractor who supplied the motor, bump it and ensure proper rotation.
8. Megger test each motor.
9. In collaboration with the contractor who supplied the motor, place the motor under load to the maximum feasible and measure

    a. Voltage and current at motor terminals on each phase and calculate balance
    b. Power factor and phasing of each motor

10. Check the overloads in comparison to FLA measured and ensure adequacy of protection and reliability.
11. Observe several start to ensure the start is reliable.
12. Measure voltage available to all phases; after motor has been placed in operation under load measure amps and RPM
13. Record all motor nameplate data

3.5 BEARINGS

A. This applies to all bearings on fans, pumps, compressors, etc.

B. Check alignment as applicable

C. Lubricate all bearings per the manufacturer’s instructions. When bearing is used for temporary conditioning, lubricate on manufacturer’s recommended frequency and document it.

3.6 FIRE PUMPS

A. General: Provide the services of a manufacturer certified specialist to supervise the installation, make adjustments, and perform tests on the Fire Pump and train Owner's maintenance personnel.

B. Start-Up Checks: Perform the following checks before start-up:

1. Check suction lines connections for tightness to avoid drawing air into the pump.
2. Clean and lubricate all bearings.
3. Refer to AC Motors in this section
4. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
5. Check that pump is free to rotate by hand. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
6. Clean associated strainers
7. Check that the proper overloads have been installed in the starter and are the correct size
8. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections
9. Align pump within manufacturers recommended tolerances
10. Ensure all associated piping has been cleaned, tested deareated.

C. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Start the pump per the manufacturer’s instructions
2. Check the general mechanical operation of the pump and motor.
3. Verify that all gages are installed, are clean and undamaged, and are functional
4. Verify that check valve seal is appropriate
5. Check noise and vibration levels and ensure they are within the manufacturers recommended tolerances.
6. Check that the NPSH is with that allowable for the operating condition.

D. Start-Up Tests: Perform a Fire Pump Hydraulic Acceptance test per NFPA 20.

1. Schedule and notify CA and Owner representatives of the Fire Pump Hydraulic Acceptance tests.
2. Perform Flow Test
3. Perform Loaded Start test (start into peak capacity)
4. Perform Phase Reversal Test
5. Perform Controller Acceptance test

E. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

1. Review data in Operating and Maintenance Manuals

3.7 FIRE SUPPRESSION SYSTEMS

A. General: Provide the services of a manufacturer certified specialist to supervise the installation, make adjustments, and perform tests on the Fire Suppression Systems and train Owner's maintenance personnel.

B. Start up and Checkout sprinkler systems per NFPA 13 Chapter 10 Systems acceptance

1. Complete NFPA Material and Test Certificate forms
2. Flush water mains prior to connection of the system
3. Hydrostatically test the systems per NFPA 13
4. For dry pipe systems, pneumatically pressure test piping per NFPA
5. Schedule and notify CA and Owner representatives of the Fire Suppression systems acceptance tests
6. Test all wet pipe zones through the inspector’s test station. Ensure proper alarming and draining. Simulate one head and jockey pump operation. Then simulate multiple zones and full fire pump operation
7. For Dry Pipe Systems: Test the dry pipe valve alone and with a quick-opening device, if installed, by opening the inspector’s test connection. The test shall measure the time to trip the valve and the time for water to be discharged from the inspector’s test connection. All times shall be measured from the time the inspector’s test connection is completely opened. The results shall be recorded using the contractor’s material and test certificate for aboveground piping.
8. For Deluge or Preaction Systems: test the automatic operation of a deluge or preaction valve in accordance with the manufacturer’s instructions. The manual and remote control operation, where present, shall also be tested.
9. Open and close all hydrants with full water pressure on the hydrant
10. PRVs: Each pressure-reducing valve shall be tested upon completion of installation to ensure proper operation under flow and no-flow conditions. Testing shall verify that the device properly regulates outlet pressure at both maximum and normal inlet pressure conditions. The results of the flow test of each pressure-reducing valve shall be recorded on the contractor’s test certificate. The results shall include the static and residual inlet pressures, static and residual outlet pressures, and the flow rate.

C. Training: Train Owner in the operation, maintenance, and inspection of the Fire Suppression Systems. Provide the owner with a copy of NFPA 25

3.8 AUTOMATIC TRANSFER SWITCHES

A. General: Provide the services of a manufacturer certified specialist to supervise the installation, make adjustments, and perform tests on the automatic transfer switches and train Owner's maintenance personnel.

B. Start-up checklists: Perform the following final checks before startup

1. Visually inspect the systems.
2. Ensure the terminations are tight and all ancillary equipment completely installed.
3. Ensure all overloads are in place.
4. Measure contact resistance
5. Complete NFPA forms as applicable

C. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Energize Switch

2. Check positive interlock between systems
3. Set/Calibrate Voltage sensing relay, transfer time delays (in both directions), and synchronization relays
4. Measure insulation resistance and resistance to ground
5. Check manual bypass operation

D. Acceptance Testing: In concert with the Fire Pump Acceptance Test, perform start tests, the power outage and endurance tests, phase reversal tests required by NFPA 20.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

1. Review data in Operating and Maintenance Manuals.

END OF SECTION 210800

SECTION 211200 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire department hose connections.
4. Fire department cabinets.
5. Fire department connections free standing.
6. Alarm devices.
7. Manual control stations.
8. Control panels.
9. Pressure gages.

B. Related Sections:
1. Division 21 Section "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
2. Division 28 Sections for alarm devices not specified in this Section.

1.3 DEFINITIONS

A. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

A. Automatic Wet-Type, Class I Standpipe System: NPS 2-1/2 (DN 65) hose connections with reducer caps for NPS 1-1/2 (DN 37) hose connections.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified NICET certified designer, using performance requirements and design criteria indicated.
1. Available fire-hydrant flow test records used as the basis of design are provided on the Drawings.

C. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.

1. Minimum residual pressure at each hose-connection outlet is as follows:
   a. NPS 2-1/2 (DN 65) Hose Connections: 100 psig (690 kPa).
2. Maximum residual pressure at required flow at each hose-connection outlet is as follows unless otherwise indicated:
   a. NPS 2-1/2 (DN 65) Hose Connections: 175 psig (1200 kPa).

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For fire-suppression standpipes. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data.

D. Coordination Drawings: Fire-suppression standpipes, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. All MEP systems

E. Qualification Data: For qualified Installer and professional engineer.

F. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations.
   1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

G. Welding certificates.

H. Fire-hydrant flow test report.

I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

J. Field quality-control reports.

K. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14, "Installation of Standpipe and Hose Systems."

E. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Fire-Suppression Standpipe Service: Do not interrupt fire-suppression standpipe service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression standpipe service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of fire-suppression standpipe service.
   2. Do not proceed with interruption of fire-suppression standpipe service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Standard-Weight, Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, seamless steel pipe with threaded ends.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).

B. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Victaulic Company Series 728
2. Standard: UL 1091 except with ball instead of disc.
3. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded or grooved ends.
4. Valves NPS 2 (DN 50): Bronze body with threaded ends or with grooved ends.

C. Bronze Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fivalco Inc.
   b. Global Safety Products, Inc.
   c. Milwaukee Valve Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Bronze.
5. End Connections: Threaded.

D. Iron Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Victaulic Company Series 705 and Series 765.
   b. Approved equal.
2. Standard: UL 1091.
3. Pressure Rating: [300 psig (2065 kPa)][365 psig (2517 kPa)].
4. Body Material: Ductile iron.
5. Style: Lug or wafer.
6. End Connections: Grooved.

E. Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. Clow Valve Company; a division of McWane, Inc.
   c. Crane Co.; Crane Valve Group; Crane Valves.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Division.
   f. Groeniger & Company.
   g. Kennedy Valve; a division of McWane, Inc.
   h. Milwaukee Valve Company.
   i. Mueller Co.; Water Products Division.
   j. United Brass Works, Inc.

k. Victaulic Company Series 717H or Series 717.
l. Viking Corporation.
m. Watts Water Technologies, Inc.

2. Standard: UL 312.
3. Pressure Rating: 365 psig (2517 kPa).
4. Type: Swing or spring-loaded check.
5. Body Material: Cast or ductile iron.
6. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. United Brass Works, Inc.
2. Standard: UL 262.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Bronze.
5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. American Valve, Inc.
c. Clow Valve Company; a division of McWane, Inc.
d. Crane Co.; Crane Valve Group; Crane Valves.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Crane Co.; Crane Valve Group; Stockham Division.
g. Hammond Valve.
h. Milwaukee Valve Company.
i. Mueller Co.; Water Products Division.
j. United Brass Works, Inc.
k. Victaulic Company Series 771.
l. Watts Water Technologies, Inc.
2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) maximum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kennedy Valve; a division of McWane, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Valves NPS 2 (DN 50) and Smaller:
a. Valve Type: Ball.
b. Body Material: Bronze.

c. End Connections: Threaded or grooved.

5. Valves NPS 2-1/2 (DN 65) and Larger:
   a. Valve Type: Butterfly.
   b. Body Material: Ductile iron.
   c. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch and visual indicating device with weather-proof actuator.

I. NRS Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. American Valve, Inc.
   c. Clow Valve Company; a division of McWane, Inc.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Kennedy Valve; a division of McWane, Inc.
   f. Mueller Co.; Water Products Division.
   g. Victaulic Company Series 772.
3. Standard: UL 262.
4. Pressure Rating: 250 psig (1725 kPa) maximum.
5. Body Material: Cast or ductile iron with indicator post flange.
6. Stem: Nonrising.
7. End Connections: Flanged or grooved.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum.

B. Angle Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fire Protection Products, Inc.
   b. United Brass Works, Inc.

C. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Affiliated Distributors.
   b. Anvil International, Inc.
   c. Barnett.
   d. Conbraco Industries, Inc.; Apollo Valves.
   e. Fire-End & Croker Corporation.
   f. Fire Protection Products, Inc.
   g. Flowserve.
   h. FNW.
   i. Jomar International, Ltd.
   j. Kennedy Valve; a division of McWane, Inc.

k. Kitz Corporation.
l. Legend Valve.
m. Metso Automation USA Inc.
n. Milwaukee Valve Company.
o. NIBCO INC.
p. Potter Roemer.
q. Red-White Valve Corporation.
r. Southern Manufacturing Group.
s. Stewart, M. A. and Sons Ltd.
t. Tyco Fire & Building Products LP.
u. Victaulic Company.
v. Watts Water Technologies, Inc.

2.6 HOSE CONNECTIONS

A. Nonadjustable-Valve Hose Connections:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. AFAC Inc.
b. Elkhart Brass Mfg. Company, Inc.
c. Fire-End & Croker Corporation.
d. Fire Protection Products, Inc.
e. GMR International Equipment Corporation.
f. Guardian Fire Equipment, Inc.
g. Kennedy Valve; a division of McWane, Inc.
h. Mueller Co.; Water Products Division.
i. NIBCO INC.
j. Potter Roemer.
k. Tyco Fire & Building Products LP.
l. Wilson & Cousins Inc.
2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300 psig (2070 kPa) minimum.
4. Material: Brass or bronze.
5. Size: NPS 2-1/2 (DN 65).
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle or gate.
9. Finish: Polished chrome plated.

B. Hose Valve Cabinets

1. Equal to Potter Roemer Model 1810 recessed valve cabinet with No. 4 finish stainless steel.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ADT Security Services, Inc.
   b. McDonnell & Miller; ITT Industries.
   c. Potter Electric Signal Company.
   d. System Sensor.
   e. Viking Corporation.
   f. Watts Industries (Canada) Inc.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

C. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AFAC Inc.
   b. Barksdale, Inc.
   c. Detroit Switch, Inc.
   d. Potter Electric Signal Company.
   e. System Sensor.
   f. Tyco Fire & Building Products LP.
   g. United Electric Controls Co.
   h. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fire-Lite Alarms, Inc.; a Honeywell company.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Potter Electric Signal Company.
   d. System Sensor.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

2.8 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK; U.S. Gauge Division.
2. Ashcroft Inc.
3. Brecco Corporation.
4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

2.9 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated finish with set-screws.

C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.

E. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated finish with concealed hinge and set-screw.

F. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.

G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.10 SLEEVES

A. Cast-Iron Wall-Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set-screws.

2.11 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex, Inc.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.12 GROUT

A. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink, and recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-Suppression Water-Service Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to fire-suppression water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-Suppression Water-Service Piping."

3.4 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.

C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
   1. In Victaulic grooved piping systems, seismic motion shall be accommodated by installing swing joints consisting of flexible couplings, pipe nipples and elbows that provide simultaneous movement in all directions, or other seismic movement compensation devices such as loops, offsets, or Style 155 expansion joints (when an in-line device is required), to provide flexibility to the system and help reduce pipe stresses. Refer to Victaulic design submittal #26.12.

D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install drain valves on standpipes. Extend drain piping to outside of building.

F. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.

G. Install alarm devices in piping systems.

H. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.
   1. Victaulic Style 009, 005, and 07 rigid couplings, with angle-pattern bolt pads may be used with IPS steel piping systems, which meet the support and hanging requirements of NFPA 13 and 14. An adequate number of Victaulic Style 177, 004, and 77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

I. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

J. Fill wet-type standpipe system piping with water.

3.5 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

E. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

G. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.6 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

3.7 HOSE-CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes.

B. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device.

C. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets."

3.8 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

3.9 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:
   1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
   2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
      a. Extend sleeves 2 inches (50 mm) above finished floor level.
      b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Sleeves for Piping Passing through Gypsum-Board Partitions:
      a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
      b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.

c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Galvanized-steel pipe.
5. Sleeves for Piping Passing through Exterior Concrete Walls:
   a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
   c. Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
6. Sleeves for Piping Passing through Interior Concrete Walls:
   a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.10 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Standard-pressure, wet-type, fire-suppression standpipe piping, NPS 4 (DN 100) and smaller , shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   3. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   4. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

C. Standard-pressure, wet-type, fire-suppression standpipe piping, NPS 6 to NPS 8 (DN 125 to DN 200), shall be one of the following:
   1. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   2. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   3. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

END OF SECTION 211200

N:\N0912.00\DOC\SPEC\2012_03-16_BID\211200 FL - FIRE-SUPPRESSION STANDPIPES.DOC

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Pipes, fittings, and specialties.
   2. Fire-protection valves.
   3. Sprinklers.
   4. Alarm devices.
   5. Manual control stations.
   6. Control panels.
   7. Pressure gages.

B. Related Sections:
   1. Division 21 Section "Fire-Suppression Standpipes" for standpipe piping.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified NICET certified designer using performance requirements and design criteria indicated.
   1. Available fire-hydrant flow test: Refer to Drawings.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 20 percent using low hydraulic gradient from water supply test data, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications: Refer to Drawings.
3. Minimum Density for Automatic-Sprinkler Piping Design: Refer to Drawings.
4. Maximum Protection Area per Sprinkler: Refer to Drawings.
5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated. Refer to Drawings.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data. Include water supply test data.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
a. All MEP systems

E. Qualification Data: For qualified Installer and professional engineer.

Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

F. Welding certificates.

G. Fire-hydrant flow test report.

H. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

I. Field quality-control reports.

J. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13, "Installation of Sprinkler Systems."

E. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Owner's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, signage, HVAC equipment, and partition assemblies.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Standard-Weight, Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, seamless steel pipe with threaded ends.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed or FM approved.
   2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).

B. Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Victaulic Company Series 728.
      b. Approved equal.
   2. Standard: UL 1091 except with ball instead of disc.
   3. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded or grooved ends.
   4. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or grooved ends.

C. Bronze Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fivalco Inc.
      b. Global Safety Products, Inc.
      c. Milwaukee Valve Company.
   2. Standard: UL 1091.
   3. Pressure Rating: 175 psig (1200 kPa).
   4. Body Material: Bronze.
   5. End Connections: Threaded.

D. Iron Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Victaulic Company.

b. Approved equal.
2. Standard: UL 1091.
3. Pressure Rating: 365 psig (2517 kPa).
4. Body Material: Ductile iron.
5. End Connections: Grooved.

E. Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. Clow Valve Company; a division of McWane, Inc.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. Groeniger & Company.
g. Kennedy Valve; a division of McWane, Inc.
h. Milwaukee Valve Company.
i. Mueller Co.; Water Products Division.
j. United Brass Works, Inc.
k. Victaulic Company.
l. Viking Corporation.
m. Watts Water Technologies, Inc.
2. Standard: UL 312.
3. Pressure Rating: 365 psig (2517 kPa) minimum.
4. Type: Swing or spring loaded check.
5. Body Material: Cast or ductile iron.
6. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. United Brass Works, Inc.
2. Standard: UL 262.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Bronze.
5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. American Valve, Inc.
c. Clow Valve Company; a division of McWane, Inc.
d. Crane Co.; Crane Valve Group; Crane Valves.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Crane Co.; Crane Valve Group; Stockham Division.
g. Hammond Valve.
h. Milwaukee Valve Company.
i. Mueller Co.; Water Products Division.
j. United Brass Works, Inc.

k. Victaulic Series 771.
l. Watts Water Technologies, Inc.

2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) maximum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kennedy Valve; a division of McWane, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Valves NPS 2 (DN 50) and Smaller:
a. Valve Type: Ball.
b. Body Material: Bronze.
c. End Connections: Threaded or grooved.
5. Valves NPS 2-1/2 (DN 65) and Larger:
a. Valve Type: Butterfly.
b. Body Material: Ductile iron.
c. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch and visual indicating device with weather-proof actuator.

I. NRS Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. American Valve, Inc.
c. Clow Valve Company; a division of McWane, Inc.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kennedy Valve; a division of McWane, Inc.
f. Mueller Co.; Water Products Division.
g. NIBCO INC.
h. Tyco Fire & Building Products LP.
2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Cast iron with indicator post flange.
5. Stem: Nonrising.
6. End Connections: Flanged or grooved.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Fire Protection Products, Inc.
    b. United Brass Works, Inc.

C. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Affiliated Distributors.
    b. Anvil International, Inc.
    c. Barnett.
    d. Conbraco Industries, Inc.; Apollo Valves.
    e. Fire-End & Croker Corporation.
    f. Fire Protection Products, Inc.
    g. Flowserve.
    h. FNW.
    i. Jomar International, Ltd.
    j. Kennedy Valve; a division of McWane, Inc.
    k. Kitz Corporation.
    l. Legend Valve.
    m. Metso Automation USA Inc.
    n. Milwaukee Valve Company.
    o. NIBCO INC.
    p. Potter Roemer.
    q. Red-White Valve Corporation.
    r. Southern Manufacturing Group.
    s. Stewart, M. A. and Sons Ltd.
    t. Tyco Fire & Building Products LP.
    u. Victaulic Company.
    v. Watts Water Technologies, Inc.

D. Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Fire Protection Products, Inc.
    b. United Brass Works, Inc.

2.6 SPECIALTY VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
    a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Automatic (Ball Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AFAC Inc.
    b. Reliable Automatic Sprinkler Co., Inc.

c. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 (DN 20).
6. End Connections: Threaded.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. National Fittings, Inc.
c. Shurjoint Piping Products.
d. Tyco Fire & Building Products LP.
e. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AGF Manufacturing Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Elkhart Brass Mfg. Company, Inc.
b. Fire-End & Croker Corporation.
c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.

8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGF Manufacturing Inc.
   b. Triple R Specialty.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
   e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CECA, LLC.
   b. Corcoran Piping System Co.
   c. Merit Manufacturing; a division of Anvil International, Inc.
2. Standard: UL 1474.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

2.8 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFAC Inc.
2. Globe Fire Sprinkler Corporation.
3. Reliable Automatic Sprinkler Co., Inc.
4. Tyco Fire & Building Products LP.
5. Venus Fire Protection Ltd.
6. Victaulic Company.
7. Viking Corporation.

B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.

C. Automatic Sprinklers with Heat-Responsive Element:
1. Nonresidential Applications: UL 199.
2. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:
1. White cover for concealed heads.

2. Chrome plated for semi-recessed pendants and sidewalls.
3. Bronze for mechanical rooms and other unfinished areas without ceilings.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
   d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.9 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AFAC Inc.
   b. Barksdale, Inc.
   c. Detroit Switch, Inc.
   d. Potter Electric Signal Company.
   e. System Sensor.
   f. Tyco Fire & Building Products LP.
   g. United Electric Controls Co.
   h. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

C. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fire-Lite Alarms, Inc.; a Honeywell company.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Potter Electric Signal Company.
   d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

2.10 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK; U.S. Gauge Division.
   2. Ashcroft, Inc.
   3. Brecco Corporation.
   4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

2.11 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated finish with set-screws.

C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.

E. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated finish with concealed hinge and set-screw.

F. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed hinge, set-screw or spring clips.

G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.12 SLEEVES

A. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set-screws.

2.13 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex, Inc.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.14 GROUT

A. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink, and recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
   1. Victaulic Style 009, 005, and 07 rigid couplings, with angle-pattern bolt pads may be used with IPS steel piping systems, which meet the support and hanging requirements of NFPA 13 and 14. An adequate number of Victaulic Style 177, 004, and 77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Fill sprinkler system piping with water.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

J. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:
1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.6 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

3.7 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:
   1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
   2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
      a. Extend sleeves 2 inches (50 mm) above finished floor level.
      b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Sleeves for Piping Passing through Gypsum-Board Partitions:
      a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
      b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
      c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
   4. Sleeves for Piping Passing through Concrete Roof Slabs: Galvanized-steel pipe.
   5. Sleeves for Piping Passing through Exterior Concrete Walls:
      a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
      b. Cast-iron wall-pipe sleeves for pipes NPS 6 (DN 150) and larger.

c. Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:
   a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.8 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.9 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.12 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves, interior above slab: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 6 (DN 125) and larger, shall be one of the following:
   1. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Concealed sprinklers.
   3. Wall Mounting: Sidewall sprinklers.
   4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
   1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
   2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
   3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
   4. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 211313

N:\N0912.00\DOC\SPEC\2012_03-16_BID\211313 FL - WET-PIPE SPRINKLER SYSTEMS.DOC

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Provide coordination drawings between all trades.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Dresser Industries, Inc.; DMD Div.
    c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
    d. JCM Industries.
    e. Smith-Blair, Inc.
    f. Viking Johnson.
2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Fernco, Inc.
    c. Mission Rubber Company.
    d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
1. Manufacturers:
    a. Capitol Manufacturing Co.
    b. Central Plastics Company.
    c. Eclipse, Inc.
    d. Epco Sales, Inc.
    e. Hart Industries, International, Inc.
    f. Watts Industries, Inc.; Water Products Div.
    g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
1. Manufacturers:
    a. Capitol Manufacturing Co.
    b. Central Plastics Company.
    c. Epco Sales, Inc.
    d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
1. Manufacturers:
    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:
   a. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Co., Inc.
   d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
      b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
         1) Seal space outside of sleeve fittings with grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Sections for cast in place concrete.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 220500

N:\N0912.00\DOC\SPEC\2012_03-16_BID\220500 - COMMON WORK RESULTS FOR PLUMBING.DOC

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Metal-bellows expansion joints.
   2. Rubber expansion joints.
   3. Flexible-hose expansion joints.
   4. Pipe bends and loops.
   5. Alignment guides and anchors.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. NR: Natural rubber.

1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Adsco Manufacturing, LLC.
b. Anamet, Inc.
c. Badger Industries.
d. Expansion Joint Systems, Inc.
e. Flex-Hose Co., Inc.
f. Flexicraft Industries.
g. Flex-Pression, Ltd.
h. Flex-Weld, Inc.
i. Hyspan Precision Products, Inc.
j. Metraflex, Inc.
k. Piping Technology & Products, Inc.
l. Proco Products, Inc.
m. Senior Flexonics, Inc.; Pathway Division.
n. Tozen America Corp.
o. Unaflex Inc.
p. WahlcoMetroflex.
q.
2. Metal-Bellows Expansion Joints for Copper Piping: Single- or multiple -ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
3. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
4. Configuration: Single- or double -bellows type, unless otherwise indicated.
5. End Connections: Flanged or weld.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adsco Manufacturing, LLC.
      b. Advanced Thermal Systems, Inc.
      c. Flex-Hose Co., Inc.
      d. Flexicraft Industries.
      e. Flex-Weld, Inc.
      f. Hyspan Precision Products, Inc.
      g. Metraflex, Inc.
      h. Piping Technology & Products, Inc.
      i. Senior Flexonics, Inc.; Pathway Division.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
   1. Stud: Threaded, zinc-coated carbon steel.
   2. Expansion Plug: Zinc-coated steel.
   3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
   1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
   3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi (20.7 MPa) minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Non-staining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.
   1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.

B. Attach guides to pipe and secure to building structure.

3.4 ANCHOR INSTALLATION

A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 220516

N:\N0912.00\DOC\SPEC\2012_03-16_BID\220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING.DOC

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Thermometers.
   2. Gages.
   3. Test plugs.

B. Related Sections:
   1. Division 22 Section "Facility Water Distribution Piping" for domestic and fire-protection water service meters outside the building.
   2. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
   3. Division 22 Section "Facility Natural-Gas Piping" for gas meters.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Palmer - Wahl Instruments Inc.
   2. Trerice, H. O. Co.

3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Description: Digital, self-powered (solar) thermometer with angle adjustment.

C. Case: High impact ABS.

D. Range: -50 to 300 degrees F.

E. Display: 3/8" LCD digits.

F. Sensor: Glass passivated thermistor.

G. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

H. Basis of Design: Weiss Model DVU35 or equal.

2.2 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Marsh Bellofram.
5. Miljoco Corp.
6. NANMAC Corporation.
7. Noshok, Inc.
8. Palmer - Wahl Instruments Inc.
9. REO TEMP Instrument Corporation.
10. Tel-Tru Manufacturing Company.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.

7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
1. Case: Dry type, metal or plastic, 4-1/2-inch (114-mm) diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass or plastic.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:
1. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
2. Snubbers: ASME B40.5, NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

D. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for water service at 20 to 200 deg F (minus 7 to plus 93 deg C) shall be CR.
2. Insert material for water service at minus 30 to plus 275 deg F (minus 35 to plus 136 deg C) shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
   1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be 0 to 200 psig (0 to 1380 kPa).
   2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F (minus 4 to plus 52 deg C).
   3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F (minus 18 to plus 104 deg C).
   4. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install thermometers in the outlet of each domestic hot-water storage tank.

B. Install thermometers at suction and discharge of each hot water circulation pump.

C. Provide the following temperature ranges for thermometers:
   1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions (Minus 1 to plus 82 deg C, with 1-degree scale divisions).
   2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions).

3.2 GAGE APPLICATIONS

A. Install pressure gages for each reduced pressure backflow preventer.

B. Install pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

D. Install needle-valve and snubber fitting in piping for each pressure gage.

E. Install test plugs in tees in piping.

F. Install permanent indicators on walls or brackets in accessible and readable positions.

G. Install connection fittings for attachment to portable indicators in accessible locations.

H. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

I. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 220519

N:\N0912.00\DOC\SPEC\2012_03-16_BID\220519 - METERS AND GAGES FOR PLUMBING PIPING.DOC

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Bronze angle valves.
   2. Bronze ball valves.
   3. Bronze lift check valves.
   4. Bronze swing check valves.
   5. Lubricated plug valves.

B. Related Sections:
   1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
   3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Block check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

E. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc.
      b. Conbraco Industries, Inc.; Apollo Valves.
      c. Crane Co.; Crane Valve Group; Crane Valves.
      d. Hammond Valve.
      e. Lance Valves; a division of Advanced Thermal Systems, Inc.
      f. Legend Valve.
      g. Milwaukee Valve Company.
      h. NIBCO INC.
      i. Red-White Valve Corporation.
      j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig (1035 kPa).
      c. CWP Rating: 600 psig (4140 kPa).
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Bronze.
      i. Ball: Chrome-plated brass.
      j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Crane Co.; Crane Valve Group; Jenkins Valves.
      d. Crane Co.; Crane Valve Group; Stockham Division.
      e. Kitz Corporation.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Red-White Valve Corporation.
      i. Zy-Tech Global Industries, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 300 psig (2070 kPa).
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded.
      f. Disc: Bronze.

2.4 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Nordstrom Valves, Inc.
      b. Approved equal.
   2. Description:
      a. Standard: MSS SP-78, Type II.
      b. CWP Rating: 200 psig (1380 kPa).
      c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      d. Pattern: Regular or short.
      e. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Nordstrom Valves, Inc.
      b. Approved equal.
   2. Description:
      a. Standard: MSS SP-78, Type II.
      b. CWP Rating: 200 psig (1380 kPa).
      c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      d. Pattern: Regular or short.
      e. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or plug valves.
   2. Throttling Service: angle or ball valves.
   3. Pump-Discharge Check Valves:
      a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
      b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
      c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
   7. For Grooved-End Copper Tubing: Valve ends may be grooved.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 4 (DN 100) and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze Angle Valves: Class 125, nonmetallic disc.
   3. Ball Valves: Two piece, reduced port, bronze with bronze trim.
   4. Bronze Swing Check Valves: Class 125, nonmetallic disc.

3.6 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, nonmetallic disc.
3. Ball Valves: Two piece, reduced port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 125, nonmetallic disc.

END OF SECTION 220523

N:\N0912.00\DOC\SPEC\2012_03-16_BID\220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING.DOC

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Fiberglass strut systems.
   5. Thermal-hanger shield inserts.
   6. Fastener systems.
   7. Pipe stands.
   8. Pipe positioning systems.
   9. Equipment supports.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
   3. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Powder-actuated fastener systems.
   4. Pipe positioning systems.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." AWS D1.4, "Structural Welding Code--Reinforcing Steel." ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   1. AAA Technology & Specialties Co., Inc.
   2. Bergen-Power Pipe Supports.
   3. B-Line Systems, Inc.; a division of Cooper Industries.
   4. Carpenter & Paterson, Inc.
   5. Empire Industries, Inc.
   6. ERICO/Michigan Hanger Co.
   7. Globe Pipe Hanger Products, Inc.
   8. Grinnell Corp.
   9. GS Metals Corp.
   10. National Pipe Hanger Corporation.
   11. PHD Manufacturing, Inc.

12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Champion Fiberglass, Inc.
3. Cope, T. J., Inc.; Tyco International Ltd.
4. Seasafe, Inc.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. B-Line Systems, Inc.; a division of Cooper Industries.
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.

2.8 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   1. Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.

c. Approved equal.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
1. Manufacturers:
a. MIRO Industries.
b. Approved equal.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
1. Manufacturers:
a. ERICO/Michigan Hanger Co.
b. MIRO Industries.
c. Portable Pipe Hangers.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
1. Manufacturers:
a. Portable Pipe Hangers.
b. Approved equal.
2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.9 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:
1. C & S Mfg. Corp.
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.

2.10 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.11 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
   10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
   11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
   12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN 25 to DN 750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN 50 to DN 600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

H. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

N:\N0912.00\DOC\SPEC\2012_03-16_BID\220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT.DOC

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook .

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:
1. Domestic & Tempered Water Piping:
   a. Background Color: Green.
   b. Letter Color: White.
2. Fuel Gas
   a. Background Color: Yellow.
   b. Letter Color: Black.
3. Sanitary Waste& Vent:
   a. Background Color: Yellow.
   b. Letter Color: Black.
4. Laboratory Waste & Vent
   a. Background Color: Yellow.
   b. Letter Color: Black.
5. Storm & Overflow Drainage Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.
6. RO Water Piping:
   a. Background Color: Blue.
   b. Letter Color: Black.
7. CO2 and Gas Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
   a. Cold Water: 1-1/2 inches (38 mm), round.
   b. Hot Water: 1-1/2 inches (38 mm), round.
   c. Fuel Gas: 1 ½ inches (38 mm) round.
   d. Pumped Waste: 1-1/2 inches (38 mm), round.
   e. Tempered Water: 1-1/2 inches (38 mm), round.
   f. RO Water: 1-1/2 inches (38 mm), round.
   g. CO2: 1-1/2 inches (38 mm), round.

2. Valve-Tag Color:
   a. Cold Water: Natural.
   b. Hot Water: Natural.
   c. Fuel Gas: Natural.
   d. Pumped Waste: Natural.
   e. Tempered Water: Natural.
   f. RO Water : Natural.
   g. CO2 :Natural.

3. Letter Color:
   a. Cold Water: Black.
   b. Hot Water: Black.
   c. Fuel Gas: Black.
   d. Pumped Waste: Black.
   e. Tempered Water: Black.
   f. RO Water : Black.
   g. CO2: Black.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

N:\N0912.00\DOC\SPEC\2012_03-16_BID\220553 - IDENTIFIATION FOR PLUMBING PIPING AND EQUIPMENT.DOC

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Mineral fiber.
   2. Adhesives.
   3. Sealants.
   4. Factory-applied jackets.
   5. Field-applied fabric-reinforcing mesh.
   6. Field-applied jackets.
   7. Tapes.
   8. Securements.
   9. Corner angles.

B. Related Sections include the following:
   1. Division 21 Section "Fire-Suppression Systems Insulation."
   2. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. LEED Submittal:
   1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at pipe expansion joints for each type of insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties, equipment connections, and access panels.
   5. Detail application of field-applied jackets.
   6. Detail application at linkages of control devices.
   7. Detail field application for each equipment type.

D. Qualification Data: For qualified Installer.

E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

F. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.

F. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; HTB 23 Spin-Glas.
      b. Owens Corning; High Temperature Flexible Batt Insulations.

G. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000(Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; CrimpWrap.
      b. Johns Manville; MicroFlex.
      c. Knauf Insulation; Pipe and Tank Insulation.
      d. Manson Insulation Inc.; AK Flex.
      e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Insulco, Division of MFS, Inc.; Triple I.
      b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

2.3 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76-8.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Vimasco Corporation; 750.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. Color: Aluminum.
   6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. Color: White.
   6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.

c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.7 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.8 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
   4. RO Piping
   5. Tempered Water

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. NPS 1 (DN 25) and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
   2. NPS 1-1/4 (DN 32) and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
   2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 1/2 inch (38 mm) thick.

C. Storm water and Overflow:
   1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

D. Roof Drain and Overflow Drain Bodies:
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
1. All Pipe Sizes: Insulation shall be the following:
a. Flexible Elastomeric: 1/2 inch (13 mm) thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

F. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

END OF SECTION 220700

N:\N0912.00\DOC\SPEC\2012_03-16_BID\220700 - PLUMBING INSULATION.DOC

SECTION 220800 – PLUMBING SYSTEM COMMISSIONOING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment testing and start-up

B. Validation of proper and thorough installation of Division 22 (Plumbing) systems and equipment

C. Systems balancing verification

D. Prefunctional performance testing of equipment and systems

E. Documentation of tests, procedures, and installations

F. Coordination of Training Events

G. Generic Start-Up Procedures for plumbing systems and equipment.

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) is retained by the Owner shall work with the Contractor and the Design Engineer to direct and oversee the Cx process and perform functional performance testing.

C. This Section outlines the Cx procedures specific to the Division 22 Contractors. Requirements common to all Sections are specified in Sections 019113 and 019114 and the Cx Plan.

1.3 SCOPE

A. The following are included in the Scope of Commissioning on this project:

B. Plumbing Systems

1. Domestic Water Systems
2. Compressed air system
3. Vacuum system
4. Pure water system
5. Specialty gas system

1.4 RELATED WORK AND DOCUMENTS

A. Commissioning Plan: The Commissioning Plan outlines the commissioning process beyond the construction specification. All Contractor responsibilities are outlined in Specifications. Cx Plan is available to the Contractor to understand the context of their responsibilities but does not define any additional responsibilities of the Contractor

B. Section 019113 – General Commissioning Requirements: details the Cx requirements common across all divisions

C. Section 019114 – Functional Testing Procedures: Outlines the generic functional testing procedures required.

D. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

E. Section 210800– Fire Suppression Systems Commissioning: Details the commissioning procedures specific to Fire Protection Systems (Div 21) work.

F. Section 230800 – HVAC Systems Commissioning: Details the commissioning procedures specific to HVAC (Div 23) work.

G. Section 230995 – Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.

H. Section 260800 – Electrical Systems Commissioning: Details the commissioning procedures specific to Division 26 work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113

1.6 REFERENCE STANDARDS

A. ASHRAE Guideline 1-1996, "Guideline for Commissioning HVAC Systems"

B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”

C. NFPA 99, “Standard for Health Care Facilities”

1.7 DOCUMENTATION

A. In addition to the documentation required in Section 019113, Contractor shall provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format. These may include but are not limited to:

a. Air Compressors
b. Pump Capacity

2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in pdf electronic format. These may include but are not limited to:

a. Pipe Pressure Testing
b. Potable Water Disinfection
c. Pure water testing

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 22.

B. Construction Phase

1. Provide skilled technicians qualified to perform the work required.
2. Provide factory-trained and authorized technicians where required by the Contract Documents.
3. Prepare and submit required draft Start-Up Procedures and submit along with the manufacturer's application, installation and start-up information.
4. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
6. Start-up, and test/adjust/balance systems and equipment prior to functional performance testing by the CA. Start-Up Procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
7. Record Start-up Procedures on start-up procedure forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.

C. Acceptance Phase

1. Assist CA in functional performance testing. Assistance will generally include the following:

a. Manipulate systems and equipment to facilitate testing (as dictated in Section 019114; in some cases this will entail only an initial sample);
b. Provide any specialized instrumentation necessary for functional performance testing;

D. Warranty Phase

1. Maintain record documentation of any configurations, set ups, parameters etc, that change throughout the period.
2. Provide representative for off season testing as required by CA.

3. Respond to Warranty issues as required by Division 1 and the General Conditions.

1.9 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

1. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of + or - 0.1°F.
2. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
3. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems shall be provided by CA.

C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

2.3 TEST KITS FOR METERS AND GAGES

A. Test kits for meters and gages shall be provided to the Owner new and in good condition. Previously used kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits included shall be as a minimum:

1. Digital indication of temperature and pressure with associated sensors to work with the P/T test ports
2. Companion readout kit (with fittings) for calibrated balancing valve with ranges as required by all devices on this project

PART 3 - EXECUTION

3.1 START-UP PROCEDURES - GENERAL

A. Part 3 of this Section outlines 'generic' or minimally acceptable Start-Up Procedures (delineated as Start-Up Checks and Start-Up Tests) and individual systems Training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimum or guideline for required Contractor development of Start-Up Procedures. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized Start-Up Procedures specific to the equipment and systems installed on this project.

3.2 PROCEDURES COMMON TO ALL SYSTEMS

A. The following start up verifications/procedures are common to all systems

B. Checkout shall proceed from devices to the components to the systems.

C. Verify labeling is affixed per spec and visible

D. Verify prerequisite procedures are done.

E. Inspect for damage and ensure none is present.

F. Verify system is applied per the manufacturer's recommendations

G. Verify system has been start up per the manufacturer's recommendations

H. Verify that access is provided for inspection, operation and repair

I. Verify that access is provided for replacement of the equipment

J. Verify the record drawings, submittal data and O&M documentation accurately reflect the installed systems

K. Verify all gages and test ports are provided as required by contract documents and manufacturer's recommendations

L. Verify all recorded nameplate data is accurate

M. Installation is done to ensure safe operation and maintenance.

N. Verify specified replacement material/attic stock has been provided as required by the Construction Documents

O. Verify all rotating parts are properly lubricated

P. Verify all monitoring and ensure all alarms are active and set per Owner's requirements

Q. Complete all nameplate data and confirm ratings conform with the design documents

3.3 VALVES

A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
2. Verify actuators are properly installed with adequate clearance.
3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable. For electronically operated valves, check the stroke and range. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.4 METERS AND GAGES

A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Adjust faces of meters and gages to proper angle for best visibility.
2. Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gages requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
3. Meters and gages requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION

A. Start-Up Checks: Perform the following checks:

1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
2. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
3. Cleaning: Clean face of identification devices and glass frames of valve charts

3.6 MECHANICAL INSULATION

A. Start-Up Checks: Examine all piping, systems and equipment specified to be insulated.

1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.
2. Ensure the integrity of vapor barrier around all cold surfaces.

3.7 PIPING - GENERAL

A. Start-Up Checks: These Procedures apply to all installed piping systems, including underground site utilities.

1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.
3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
4. Provide notification of pipe cleaning and flushing activities
5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
6. Ensure adequate drainage is provided at low points and venting is provided at high points.
7. Ensure air is thoroughly removed from the system as applicable. Ensure facilities to effectively drain and fill the system are in place.
8. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
9. Provide notification of pressure testing
10. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
11. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
12. Submit pressure test reports that document the pressure testing results with Certification of the results.
13. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
14. Set and adjust fill, pressure, or level controls to the required setting.

3.8 AC MOTORS

A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Verify proper alignment, installation, and rotation.
2. Verify properly sized overloads are in place

B. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:

1. Measure insulation resistance, phase balance, and resistance to ground
2. Measure voltage available to all phases; measure amps and RPM after motor has been placed in operation and is under load.
3. Record all motor nameplate data.

3.9 BEARINGS

A. This applies to all bearings on fans, pumps, compressors, etc.

B. Check alignment as applicable

C. Lubricate all bearings per the manufacturer's instructions. When bearing is used for temporary conditioning, lubricate on manufacturer's recommended frequency and document it.

3.10 LABORATORY AIR COMPRESSORS AND VACUUM PUMPS

A. General: Provide the services of a factory authorized representative to inspect equipment installation and start-up equipment, and train the Owner's personnel

B. Safety Controls: Operate and adjust safety controls. Replace damaged and malfunctioning controls and equipment.

C. Refer to AC Motors elsewhere in this Section.

D. Start-Up Checks: Perform the following checks before start-up:

1. Verify that specified tests of piping systems are complete.
2. Check that medical air compressor inlets are properly located for clean air supply, and that medical vacuum exhausts are properly located to prevent contamination of medical air compressor inlets and public spaces.
3. Check that medical air compressor inlet filters and piping and medical vacuum pump filters and discharge piping are clear.
4. Check for lubricating oil for lubricated-type equipment.
5. Check V-belts for proper tension.
6. Check for equipment vibration control supports and flexible pipe connectors and that equipment is properly attached to substrate.
7. Check that safety (pressure relief) valves have a setting greater than medical air compressor discharge pressure but not greater than pressure rating of system components.
8. Adjust vacuum relief valves.
9. Check for water supply to water-cooled equipment.
10. Check for water supply to liquid ring medical air compressors and vacuum pumps.
11. Drain medical air and vacuum receiver tanks.
12. Check for proper seismic restraints.
13. Check for adequate room ventilation.

E. Start-Up Tests: Follow the manufacturer's printed procedures. If no procedures are specified by the manufacturer, proceed as follows:

1. Energize circuits.
2. Start and run equipment through complete sequence of operations.
3. Check for excessive vibration and noise.
4. Check air and vacuum pressures.
5. Manually operate safety valves and vacuum relief valves.
6. Adjust operating controls including pressure and vacuum settings.

F. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

1. Review data in Operating and Maintenance Manuals

3.11 HIGH PURITY WATER SYSTEM

A. General: Provide the services of a factory authorized representative to inspect equipment installation and start-up equipment, and train the Owner's personnel

1. Refer to applicable elements itemized elsewhere in this section like pumps, water softeners piping, etc. as applicable.

B. Start-up Checks: Perform the following checks before start-up:

1. Ensure piping is properly installed, sterilized, and tested.
2. Fill brine tank.
3. Ensure 3 valve bypass, pressure gages, and sample valve are installed on the UV sterilizer and Pre- and Final Filters.
4. Ensure isolation valves are installed throughout the system as required by the specifications.
5. For the UV sterilizer, ensure proper power source is provided and connected. Also verify the interface with the BAS for on/off, high temp alarm, no flow alarm.
6. At the DI Columns, ensure each can be isolated for service, each column is properly secured to frame, manual isolation valve is installed on the common discharge header, resistivity monitor is installed and connected to the BAS, and sample valve is provided.
7. Verify storage tank fill and level controls are installed and functional.
8. Validate that sunlight cannot get to stored pure water

C. Start-Up Tests: Follow the manufacturer's printed procedures as a minimum:

1. Start-up and check out booster pumps in accordance with the item so labeled in this Section.
2. Run pre-treatment through all regeneration and backwash cycles.
3. Verify blending valve is operational.
4. Test the storage tank makeup and fill and associated alarming function.
5. Calibrate all sensors including resistivity meters.
6. Verify all modes of operation and ensure that the controls, alarms and safeties are functional and properly adjusted.
7. Perform bacteria and TOC test.
8. Verify record documentation represents installed conditions

D. Functional Performance Tests: The acceptance of the Pure Water System will be done in concert with the factory authorized representatives testing after start up. Manufacturer's representative will conduct all functional testing in the presence of the CxT. Coordinate Manufacturer's start up and testing with functional testing on support utilities.

1. Demonstrate Access to equipment for maintenance and repair
2. Present Record Documentation
3. CA to review start up documentation
4. Normal Operation Tests:

a. Open Pure Water Outlets to load the system to near capacity.
b. Monitor booster pumps and temperature mixing valves for proper operation.
c. Observe softener cycles and rotation of softeners as backwash cycles are initiated.
d. Confirm RO system operation and monitoring
e. Confirm proper UV sterilizer operation
f. Confirm proper recirculation flows

g. Check pressures in relation to ratings of terminal devices
h. Inspect for dead legs and ensure sunlight is not available to storage tanks.
i. Spot check balancing of the circulation system to ensure adequate flow
j. Test pumps in accordance with the procedure indicated for them elsewhere in the plan.

5. During normal operation take samples as follows:

a. TOC Tests: Samples shall be taken at 10 locations as specified by the CxA. Use a calibrated TOC analyzer with documented calibration within the last 6 months. Appropriately bleed outlet prior to taking sample.
b. Bacteria Tests: Samples shall be taken at 10 locations as specified by the CxA. Take 100 milliliter samples and culture for 72 hours.
c. TDS: Samples shall be taken at 10 locations as specified by the CxA. Measure the total dissolved solids using a calibrated meter with certification within 6 months.
d. Documentation shall contrast the measured sample with the threshold for the applicable reagent grade spec.

6. Normal Maintenance:

a. During normal operation, systematically take redundant components out of service to simulate them being serviced or repaired. Ensure system continues operation without interruption. Demonstrate replacing filters and media.

7. Emergency Operation:

a. Simulate failures of various components and sensors. Ensure proper responses to failures and proper enunciation of condition.

E. Training: Factory-authorized representative shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals

3.12 WATER HEATERS

A. General: Provide the services of a factory authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train Owner's maintenance personnel as specified below.

1. Check for piping connections leaks.
2. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.
3. Set all DHW recirculation flow rates and time the delivery of hot water at the remote branches of the system.

B. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

1. Review data in Operating and Maintenance Manuals.

3.13 COMPRESSED AIR SYSTEMS

A. General: Provide the services of a factory authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

B. Refer to AC Motors in this section

C. Start-Up Checks: Perform the following final checks before startup:

1. Piping System Tests: Complete system test in accordance with the respective section
2. Inspect the installation and access/clearance for service and maintenance to ensure it meets the project and manufacturer’s requirements
3. Check for piping connection leaks.
4. Check lubricating oil for lubricated type equipment.
5. Check V-belts for proper tension.
6. Check that compressor inlet filters and piping are clear.
7. Check equipment vibration control supports and flexible pipe connectors, and that equipment is properly attached to substrate.
8. Check for proper seismic restraints.
9. Check that safety valves have correct setting; greater than compressor discharge pressure, but not greater than pressure rating of system components.
10. Test operation of equipment safety controls and devices.
11. Check water supply to water cooled equipment.
12. Check water supply to liquid ring air compressors.
13. Drain receiver tanks.
14. Check for adequate room ventilation.

D. Start-Up Tests: Follow the manufacturer's written procedures and the following as a minimum:

1. Energize circuits.
2. Check for proper rotation of 3 phase motors.
3. Start and run equipment through complete sequence of operations.
4. Check for excessive vibration and noise. Correct problems.
5. Check air pressures.
6. Manually operate safety valves.
7. Adjust operating controls including pressure settings.

E. Training: Factory-authorized representative shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals

3.14 PUMPS

A. Refer to AC Motors in this section

B. Refer to Bearings in this section

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

D. Start-Up Checks: Perform the following checks before start-up:

1. Check suction lines connections for tightness to avoid drawing air into the pump.
2. Clean and lubricate all bearings.
3. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
5. Clean associated strainers.
6. Check that the proper overloads have been installed in the starter and are the correct size.
7. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections.
8. Align pump within manufacturers recommended tolerances.
9. Ensure all associated piping has been cleaned, tested, and vented.
10. Verify that all thermometers and gages are installed, are clean and undamaged, and are functional.

E. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Start the pump per the manufacturer's instructions.
2. Check the general mechanical operation of the pump and motor.
3. Verify that check valve seal is appropriate.
4. Check noise and vibration levels and ensure they are within the manufacturers recommended tolerances.
5. Check that the NPSH is with that allowable for the operating condition.
6. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.15 SEQUENCING ILLUSTRATION

A. Reference Section 019113

END OF SECTION 220800

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Escutcheons.
   3. Sleeves and sleeve seals.
   4. Wall penetration systems.

B. Related Section:
   1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 SUBMITTALS

A. Product Data: For the following products:
   1. Specialty valves.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Flexible connectors.
   5. Backflow preventers.
   6. Escutcheons.
   7. Sleeves and sleeve seals.
   8. Water penetration systems.

B. LEED Submittal:
   1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Water Samples: Specified in "Cleaning" Article.

D. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to 1/4” scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. All MEP systems

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components.

C. Comply with NSF 61 for potable domestic water piping and components.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
   1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
   5. Grooved-Joint Copper-Tube Appurtenances:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Anvil International.
         2) Shurjoint Piping Products.
         3) Victaulic Company.
      b. Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
      c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. EPCO Sales, Inc.
   d. Hart Industries International, Inc.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Wilkins Water Control Products.
2. Description:
   a. Pressure Rating: 150 psig (1035 kPa) at 180 deg F (82 deg C).
   b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. EPCO Sales, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Factory-fabricated, bolted, companion-flange assembly.
   b. Pressure Rating: 150 psig (1035 kPa).
   c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig (1035 kPa).
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.
2. Description:
   a. Galvanized-steel coupling.
   b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
   c. End Connections: Female threaded.
   d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Precision Plumbing Products, Inc.
   c. Victaulic Company.
2. Description:
   a. Electroplated steel nipple complying with ASTM F 1545.
   b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
   c. End Connections: Male threaded or grooved.
   d. Lining: Inert and noncorrosive, propylene.

2.5 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.

E. Split Casting, Cast Brass: **Polished, chrome-plated** finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with **concealed** hinge, **setscrew or spring clips**.

G. One-Piece Floor Plates: Cast-iron flange **with holes for fasteners**.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.6 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with setscrews.

2.7 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.8 WALL PENETRATION SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. SIGMA.
2. Proset
3. Approved equal.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
3. Housing-to-Sleeve Gasket: EPDM rubber.
4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
5. Pipe Sleeve: ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

2.9 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install domestic water piping level **with 0.25 percent slope downward toward drain** and plumb.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

I. Install piping adjacent to equipment and specialties to allow service and maintenance.

J. Install piping to permit valve servicing.

K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

L. Install piping free of sags and bends.

M. Install fittings for changes in direction and branch connections.

N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

O. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

P. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

Q. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 (DN 50) and smaller. Use ball valves for piping NPS 2-1/2 (DN 65) and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
   1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
   2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 (DN 50) and smaller and butterfly valves for piping NPS 2-1/2 (DN 65) and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

F. Install supports for vertical copper tubing every 10 feet (3 m).

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
   4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.7 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using wall penetration systems specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:
   1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
   2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
      a. Extend sleeves 2 inches (50 mm) above finished floor level.
      b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches

(50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:
   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
   c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
5. Sleeves for Piping Passing through Exterior Concrete Walls:
   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
   c. Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
   d. Do not use sleeves when wall penetration systems are used.
6. Sleeves for Piping Passing through Interior Concrete Walls:
   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.8 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.9 WALL PENETRATION SYSTEM INSTALLATION

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.10 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.12 ADJUSTING

A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.13 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:
        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.14 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought- copper solder-joint fittings; and soldered joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 6 (DN 65 to DN 100), shall be the following:
1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought- copper solder-joint fittings; and brazed joints.

3.15 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, with flanged ends for piping NPS 2-1/2 (DN 65) and larger.

2. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221116 - DOMESTIC WATER PIPING.DOC

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose stations.
9. Hose bibbs.
10. Wall hydrants.
11. Ground hydrants.
12. Post hydrants.
13. Drain valves.
14. Water hammer arresters.
15. Air vents.
16. Trap-seal primer valves.
17. Trap-seal primer systems.

B. Related Sections include the following:
1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:
   1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
   2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Co.
      b. Cash Acme.
      c. Conbraco Industries, Inc.
      d. FEBCO; SPX Valves & Controls.
      e. Rain Bird Corporation.
      f. Toro Company (The); Irrigation Div.
      g. Watts Industries, Inc.; Water Products Div.
      h. Zurn Plumbing Products Group; Wilkins Div.
   3. Standard: ASSE 1001.
   4. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
   5. Body: Bronze.
   6. Inlet and Outlet Connections: Threaded.
   7. Finish: Chrome plated.

B. Pressure Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      d. Flomatic Corporation.
      e. Toro Company (The); Irrigation Div.
      f. Watts Industries, Inc.; Water Products Div.
      g. Zurn Plumbing Products Group; Wilkins Div.
   2. Standard: ASSE 1020.
   3. Operation: Continuous-pressure applications.

4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Accessories:
   a. Valves: Ball type, on inlet and outlet.

C. Spill-Resistant Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:
   a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements and approval by the authority having jurisdiction, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 (DN 50) and smaller; for NPS 2-1/2 (DN 65) and larger.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller;
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
   a. Valves: Ball type with threaded or flanged ends on inlet and outlet of NPS 4 (DN 50) and smaller.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Hose-Connection Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water (30-kPa) back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm (0.19-L/s) flow.

C. Backflow-Preventer Test Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.

c. Flomatic Corporation.
d. Watts Industries, Inc.; Water Products Div.
e. Zurn Plumbing Products Group; Wilkins Div.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.3 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong International, Inc.
b. Flo Fab Inc.
c. ITT Industries; Bell & Gossett Div.
d. NIBCO INC.
e. TAC Americas.
f. Taco, Inc.
g. Watts Industries, Inc.; Water Products Div.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: bronze,
4. Size: Same as connected piping, but not larger than NPS 2 (DN 50).
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.4 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller;flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
a. StrainersNPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
6. Drain: Factory-installed, hose-end drain valve.

2.5 HOSE BIBBS

A. Hose Bibbs (HB-1, HB-2):
1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1052.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.

10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.6 WALL HYDRANTS

A. Wall Hydrants (WH-1):
1. Equal to Jay R. Smith No.5519-WC dual check valve wall hydrant.
2. Standard: ASSE 1052, Type A or Type B.
3. Type: Freeze-resistant, automatic draining.
4. Classification: Type A, for automatic draining with hose removed o.
5. Pressure Rating: 125 psig (860 kPa).
6. Operation: Loose key .
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 3/4 (DN 20).
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.7 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants (PH-1):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. Prier Products, Inc.
   c. Simmons Manufacturing Co.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Woodford Manufacturing Company.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, exposed-outlet post hydrant.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Casing: Bronze with casing guard.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.
10. Vacuum Breaker: Nonremovable, drainable, hose-connection backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.
11. Operating Key(s): Two with each loose-key-operation wall hydrant.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (WHA):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. PPP Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves (TP):
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. MIFAB, Inc.
   b. PPP Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig (860 kPa) minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
8. Equal to PPP Model P2-500 floor drain trap primer with DU-U distribution unit.

B. Automatic Type, Trap Seal Primer Assembly, Mechanical Rooms (TPA)
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. PPP Inc.

b. Approved equal.
2. Standard: ASSE 1044.
3. Pressure Rating: 125 psig (860 kPa) minimum.
4. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
5. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
6. Equal to PPP Model MP-500-115V electronic trap primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install trap primers in accordance with manufacturer’s written instructions.

E. Install water hammer arresters in water piping according to PDI-WH 201.

F. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.

3. Reduced-pressure-principle backflow preventers.
4. Calibrated balancing valves.
5. Hose stations.
6. Supply-type, trap-seal primer valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, and double-check backflow-prevention assembly, according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

END OF SECTION 221119

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221119 - DOMESTIC WATER PIPING SPECIALTIES.DOC

SECTION 221120 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes constant-speed, duplex, packaged booster pumps for domestic water piping systems.

1.3 SUBMITTALS

A. Product Data: For each packaged booster pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: For packaged booster pumps and accessories. Include plans, elevations, sections, details, and attachments to other work.
   1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
   3. Wiring Diagrams: Detail power, signal, and control wiring.

C. Operation and Maintenance Data: For each packaged booster pump to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged booster pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance: Comply with ASME B31.9 for piping.

D. Packaged booster pumps shall be listed and labeled as pumping systems by testing agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Bell & Gossett and no others.

2.2 CONSTANT-SPEED, DUPLEX BOOSTER PUMPS

A. Description: Factory-assembled and -tested, packaged booster pump with multiple pumps, piping, valves, sensors, and controls on skids or base.

B. System Working-Pressure Rating: 175 psig (1200 kPa) minimum.

C. Pump Arrangement: Duplex, with two equal-size pumps.

D. Pumps: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and HI 1.1-1.2 and HI 1.3.
   1. Each Pump:
      a. Orientation: Mounted horizontally or vertically.
      b. Construction: Bronze fitted.
         1) Casing: Radially split, cast iron.
         2) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
         3) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
         4) Seal: Mechanical.

E. Motors: Single speed, with oil-lubricated bearings, unless otherwise indicated. Select motor that will not overload through full range of pump performance curve. Comply with Division 22 Section "Common Motor Requirements for Plumbing Equipment."

F. Control Valves: Adjustable, automatic, pilot-operated pressure regulator on each pump discharge.

G. Relief Valves: Adjustable, pressure relief type on pump discharge.

H. Piping: ASME B31.9 for piping materials and installation.

1. NPS 4 (DN 100) and Smaller: ASTM B 88, Type L (ASTM B 88M, Type B), drawn copper water tube; with copper solder-joint pressure fittings, and brazed joints.
2. Header End Connections:
   a. NPS 2 (DN 50) and Smaller: Threaded.
   b. NPS 2-1/2 (DN 65) and Larger: Flanged.
3. Piping Option: Piping, including valves and other components, may have grooved ends for grooved joints.

I. Valves: Include shutoff valve at each pump suction, and shutoff valve and check valve at each pump discharge.
1. Shutoff Valves, NPS 2 (DN 50) and Smaller: MSS SP-80, Class 125, bronze rising-stem gate valve or MSS SP-110, 600-psig (4135-kPa) minimum CWP, bronze ball valve with ends matching piping.
2. Shutoff Valves, NPS 2-1/2 (DN 65) and Larger: MSS SP-70, Class 125, bronze-trim, OS&Y, cast-iron gate valve with flanged ends or MSS SP-67, Type I for tight shutoff, 175-psig (1200-kPa) CWP, single-flanged, cast-iron butterfly valve.
3. Check Valves, NPS 2 (DN 50) and Smaller: Spring- or lever-loaded, MSS SP-80, Class 125, bronze, swing check valve.
4. Check Valves, NPS 2-1/2 (DN 65) and Larger: Spring- or lever-loaded, MSS SP-71, Class 125, bronze-trim, cast-iron, swing check valve.

J. Sensors: Pressure and flow switches.

K. Dielectric Fittings: With insulating material isolating joined dissimilar metals to prevent galvanic action and to stop corrosion.
1. NPS 2 (DN 50) and Smaller: Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
2. NPS 2-1/2 (DN 65) and Larger: Factory-fabricated, companion-flange assembly; for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

L. Control Panel: Factory installed and connected as an integral part of unit complying with NEMA ICS 2 and UL 508; automatic for multiple-pump, constant-speed operation, with load control and protection functions.
1. Enclosure: NEMA 1.
2. Motor Controller: Full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.
3. Motor Overload Protection: Overload relay in each phase.
4. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
   a. Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.
5. Instrumentation: Unit suction and discharge pressure gages.
6. Lights: Running light for each pump.
7. Alarm Signal Device: Sounds alarm when backup pumps are operating.
8. High-suction pressure cutout.
9. High-discharge pressure cutout.
10. Remote signal contacts.

M. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and pump nozzles.

N. Capacity and Characteristics:
1. System Capacity: 150 gpm (L/s).

2. Inlet Pressure: 50 psig (kPa) min.
3. Discharge Pressure: 80 psig (kPa) max.
4. Inlet and Outlet Header Size: 3 inch.
5. Lead Pump:
   a. Capacity: 150 gpm (L/s).
   b. Total Dynamic Head: 65 feet (kPa).
   c. Speed: 1750 rpm.
   d. Control Valve: Manufacturer standard.
   e. Motor Horsepower: 3.
   f. Electrical Characteristics:
      1) Volts: 480.
      2) Phases: Three.
      3) Hertz: 60.
6. Lag Pump:
   a. Capacity: 150 gpm (L/s).
   b. Total Dynamic Head: 65 feet (kPa).
   c. Speed: 1750 rpm.
   d. Control Valve: Manufacturer standard.
   e. Motor Horsepower: 3.
   f. Electrical Characteristics:
      1) Volts: 480.
      2) Phases: Three.
      3) Hertz: 60.

2.3 FLEXIBLE CONNECTORS

A. Manufacturers:
1. Anamet, Inc.
2. Flex-Hose Co., Inc.
3. Flexicraft Industries.
4. Flex-Pression, Ltd.
5. Flex-Weld, Inc.
6. Hyspan Precision Products, Inc.
7. Mercer Rubber.
8. Metraflex, Inc.
9. Proco Products, Inc.
10. Tozen America Corporation.
11. Unaflex Inc.

B. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze-welded to tubing. Include 175-psig (1200-kPa) minimum working-pressure rating and ends according to the following:
1. NPS 2 (DN 50) and Smaller: Threaded. Provide flanged ends if pump has flanged connections.
2. NPS 2-1/2 (DN 65) and Larger: Flanged.

2.4 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for packaged booster pumps to verify actual locations of connections before booster pump installation.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for packaged booster pumps. Refer to Division 22 Section "Common Work Results for Plumbing."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
   4. Install anchor bolts to elevation required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 BOOSTER PUMP INSTALLATION

A. Install packaged booster pumps level on concrete bases with access for periodic maintenance including removal of pumps, motors, impellers, couplings, and accessories.
   1. Do not dismantle packaged booster pumps or remove individual components.

B. Vibration Isolation: Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Support connected domestic water piping so weight of piping is not supported by packaged booster pumps.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic water piping to packaged booster pumps. Install suction and discharge pipe equal to or greater than size of unit suction and discharge headers.
   1. Install flexible connectors on piping connections to unit suction and discharge headers. Install flexible connectors same size as piping.
   2. Install shutoff valves on piping connections to each booster pump suction and discharge headers. Install ball, butterfly, or gate valves same size as suction and discharge headers. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
   3. Install union or flanged connections on pump suction and discharge **headers** at connection to domestic water piping.
   4. Install piping adjacent to packaged booster pumps to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform the following startup service:
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers if any.
   4. Verify that pump controls are correct for required application.

B. Perform the following startup checks for each pump of packaged booster pump unit before starting:
   1. Verify bearing lubrication.
   2. Prime pumps by opening suction valves and closing discharge valves, and prepare pumps for operation.
   3. Start motors.
   4. Open discharge valves slowly.
   5. Adjust settings.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting packaged booster pumps to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.6 LABELING AND IDENTIFICATION

A. Install identifying equipment markers and equipment signs on booster pumps. Labeling and identification materials are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged booster pumps. Refer to Division 01 Section "Demonstration and Training"

END OF SECTION 221120

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221120 - DOMESTIC WATER PACKAGED BOOSTER PUMPS.DOC

SECTION 221123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.
   5. Pressure regulators.
   6. Mechanical sleeve seals.
   7. Grout.
   8. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
   2. Service Regulators: 100 **psig** minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less .

1.5 SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.

2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Dielectric fittings.
5. Mechanical sleeve seals.
6. Escutcheons.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for **service meter assembly and** pressure regulator assembly.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

D. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

E. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

F. Qualification Data: For qualified professional engineer.

G. Welding certificates.

H. Field quality-control reports.

I. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      a. Material Group: 1.1.
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
   5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
   6. Mechanical Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Dresser Piping Specialties; Division of Dresser, Inc.
         2) Smith-Blair, Inc.
      b. Steel flanges and tube with epoxy finish.
      c. Buna-nitrile seals.
      d. Steel bolts, washers, and nuts.
      e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
      f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.2 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig.
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BrassCraft Manufacturing Company; a Masco company.
      b. Conbraco Industries, Inc.; Apollo Div.
      c. Lyall, R. W. & Company, Inc.
      d. McDonald, A. Y. Mfg. Co.
      e. Perfection Corporation; a subsidiary of American Meter Company.
   2. Body: Bronze, complying with ASTM B 584.
   3. Ball: Chrome-plated brass.
   4. Stem: Bronze; blowout proof.
   5. Seats: Reinforced TFE; blowout proof.
   6. Packing: Separate packnut with adjustable-stem packing threaded ends.
   7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   8. CWP Rating: 600 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Lee Brass Company.
      b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flowserve.
   b. Homestead Valve; a division of Olson Technologies, Inc.
   c. McDonald, A. Y. Mfg. Co.
   d. Milliken Valve Company.
   e. Mueller Co.; Gas Products Div.
   f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.4 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Carbon steel.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.7 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to **NFPA 54 and the International Fuel Gas Code** to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with **NFPA 54 and the International Fuel Gas Code** requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with **NFPA 54 the International Fuel Gas Code** for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
   1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

D. Install fittings for changes in direction and branch connections.

E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

F. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

H. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

A. Comply with **NFPA 54** and **the International Fuel Gas Code** for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      c. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      d. Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
      e. Piping in Equipment Rooms: One-piece, cast-brass type.
      f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
   1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
   2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
      a. Exception: Tubing passing through partitions or walls does not require striker barriers.
   3. Prohibited Locations:
      a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
      b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:
1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 Section for plumibng piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
1. Alkyd System: MPI EXT 5.1D.
   a. Prime Coat: Alkyd anticorrosive metal primer.
   b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
   c. Topcoat: Exterior alkyd enamel (semigloss).
   d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to **NFPA 54 and the International Fuel Gas Code** and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 231123

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221123 - FACILITY NATURAL GAS PIPING- .DOC

SECTION 221316 – STORM DRAINAGE AND SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.
   3. Encasement for underground metal piping.

B. Related Sections include the following:
   1. Division 22 Section "Sanitary Sewerage Pumps."

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.
   2. Sanitary Sewer, Force-Main Piping: 50 psig .

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. LEED Submittal:
   1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.

D. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
   1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
      a. Manufacturers:
         1) ANACO.
         2) Clamp-All Corp.
         3) Ideal Div.; Stant Corp.
         4) Mission Rubber Co.
         5) Tyler Pipe; Soil Pipe Div.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
   1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
   1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

C. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Solvent Cement and Adhesive Primer:
1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
1. Manufacturers:
   a. Dallas Specialty & Mfg. Co.
   b. Fernco, Inc.
   c. Logan Clay Products Company (The).
   d. Mission Rubber Co.
   e. NDS, Inc.
   f. Plastic Oddities, Inc.
2. Sleeve Materials:
   a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
   b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
1. Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Mission Rubber Co.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
   1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Copper DWV tube, copper drainage fittings, and soldered joints.
   3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, Storm and OverFlow piping NPS 4 and smaller shall be the following:
   1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

D. Aboveground, soil and waste piping NPS 5 and larger shall be the following:
   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

E. Aboveground, Storm and Over Flow NPS 5 and larger shall be the following:
   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

F. Aboveground, vent piping **NPS 4 and smaller** shall be the following:
   1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Copper DWV tube, copper drainage fittings, and soldered joints.
      a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
   3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

G. Underground, soil, waste, and vent piping NPS 12 and smaller shall be the following:
   1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
   2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

H. Aboveground waste force mains NPS 1-1/2 and NPS 2 shall be the following:
   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
   2. Steel pipe, pressure fittings, and threaded joints.

3.3 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

C. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

E. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

H. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install soil, storm and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary and Strom Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary and Strom Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

K. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

L. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

D. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Install individual, straight, horizontal piping runs according to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install supports for vertical steel piping every 15 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

D. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary and storm drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221316 - STORM DRAINAGE AND SANITARY WASTE AND VENT PIPING.DOC

SECTION 221319 - SANITARY WASTE AND STORM PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

B. Cleanouts.
   1. Floor drains.
   2. Roof drains
   3. Roof flashing assemblies.
   4. Through-penetration firestop assemblies.
   5. Miscellaneous sanitary drainage piping specialties.
   6. Flashing materials.

C. Related Sections include the following:
   1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
   g. Josam Company; Blucher-Josam Div.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk , drilled-and-threaded cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. FD-1: Equal to Jay R. Smith model 2005-P050-NB. Cast iron body floor drain with primer connection and nickel bronze strainer. Above grade- NO-HUB Connection. On-grade- threaded outlet connection (-T).
2. FD-2: Equal to Jay R. Smith model 2131Y-P050. Medium duty cast iron floor drain with sediment bucket and trap primer connection.
3. FD-3: Equal to Jay R. Smith model 2242C-P050. Heavy duty deep drain with sediment bucket.

2.3 BACKWATER VALVES

A. BWV: Equal to Jay R. Smith model 7022S. Cast iron body backwater valve with threaded access cover, hub inlet and spigot outlet.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch- (2.4-mm-) thick, lead flashing collar and skirt extending at least 10 inches (250 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.

B. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

2.7 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).
2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm thickness).

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
   b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
   c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Install through-penetration firestop assemblies in plastic stacks at floor penetrations.

I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

L. Install vent caps on each vent pipe passing through roof.

M. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221319 - SANITARY WASTE AND STORM PIPING SPECIALTIES.DOC

SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following sump pumps and accessories, inside the building, for building storm drainage systems:
   1. Submersible sump pumps.

1.3 SUBMITTALS

A. Product Data: For each type and size of sump pump specified. Include certified performance curves with operating points plotted on curves, and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For each sump pump to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sump pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of concrete pits. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SUBMERSIBLE SUMP PUMPS

A. Manufacturers:
   1. ABS Pumps, Inc.
   2. Aermotor Pumps, Inc.
   3. Barnes; Crane Pumps & Systems.
   4. Bell & Gossett Domestic Pump; ITT Industries.
   5. BJM Corporation.
   6. EBARA International Corporation; Standard Pump Division.
   7. Federal Pump Corp.
   8. Gorman-Rupp Company (The).
   9. Goulds Pumps; ITT Industries.
   10. Grundfos Pumps Corp.
   11. Liberty Pumps.
   12. Little Giant Pump Co.
   13. McDonald, A. Y. Mfg. Co.
   14. Metropolitan Industries, Inc.
   15. Myers, F. E.; Pentair Pump Group (The).
   16. Paco Pumps, Inc.
   17. Stancor, Inc.
   18. Sta-Rite Industries, Inc.
   19. Swaby Manufacturing Co.
   20. Weil Pump Company, Inc.
   21. Weinman Div.; Crane Pumps & Systems.
   22. Zoeller Company.

B. Description: Factory-assembled and -tested, simplex , single-stage, centrifugal, end-suction, submersible, direct-connected sump pumps complying with UL 778 and HI 1.1-1.2 and HI 1.3 for submersible sump pumps.

C. Casing: Stainless steel; with stainless-steel inlet strainer, legs that elevate pump to permit flow into impeller, and vertical discharge with companion flange suitable for piping connection.

D. Impeller: Stainless steel or other corrosion-resistant material.

E. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings and double-mechanical seals.

F. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection; three-conductor waterproof power cable of length required, and with grounding plug and cable-sealing assembly for connection at pump. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
1. Moisture-Sensing Probe: Internal moisture sensor with moisture alarm.

G. Pump Discharge Piping: Factory or field fabricated, copper tube.

H. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with float, float rod, and rod buttons.

I. Controls: Equal to Stancor Oil Minder System with oil sensor and float switch.

J. Capacity and Characteristics:
1. Number of Pumps: One.
2. Pump:
   a. Capacity: 74 gpm.
   b. Total Dynamic Head: 25 feet.
   c. Speed: 3600 rpm.
   d. Discharge Pipe Size: 2" NPS.
   e. Motor Horsepower: 0.5.
   f. Electrical Characteristics:
      1) Volts: 120
      2) Phases: Single.
      3) Hertz: 60.
   g. Unit Electrical Characteristics:
      1) Full-Load Amperes: 5.
      2) Minimum Circuit Ampacity:
      3) Maximum Overcurrent Protection:
3. Alternator Control Required: No.
4. Equal to Stancor model SE-50.

2.3 FLEXIBLE CONNECTORS

A. Manufacturers:
1. Anamet, Inc.
2. Flex-Hose Co., Inc.
3. Flexicraft Industries.
4. Flex-Pression, Ltd.
5. Flex-Weld, Inc.
6. Hyspan Precision Products, Inc.
7. Mercer Rubber.
8. Metraflex, Inc.
9. Proco Products, Inc.
10. Tozen America Corporation.
11. Unaflex Inc.

B. Description: 125-psig (860-kPa) minimum working-pressure rating and ends matching pump connection:

1. Bronze Flexible Connectors: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to tubing.
2. Stainless-Steel Flexible Connectors: Corrugated, stainless-steel inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to tubing.

2.4 BUILDING AUTOMATION SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
   1. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 SUMP PUMP INSTALLATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

B. Install sump pumps according to applicable requirements in HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Set submersible sump pumps on pit floor. Make direct connections to storm drainage piping.

E. Support piping so weight of piping is not supported by pumps.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to sump pumps to allow service and maintenance.

C. Install discharge piping equal to or greater than size of pump discharge piping. Refer to Division 22 Section "Facility Storm Drainage Piping."
   1. Install flexible connectors adjacent to pumps in discharge piping.
   2. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for drainage piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify bearing lubrication.
   3. Disconnect couplings and check motors for proper direction of rotation.
   4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   5. Verify that pump controls are correct for required application.

B. Start pumps without exceeding safe motor power:
   1. Start motors.
   2. Open discharge valves slowly.
   3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.
   1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
   2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 221429

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221429 - SUMP PUMPS.DOC

SECTION 221513 - LABORATORY SERVICE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provision of Contract, including General and Supplementary Conditions and Division 1 specifications, apply to this section.

B. Where Paragraphs of this Section conflict with similar paragraphs of the General and Supplementary Conditions and Division 1, requirements of this Section shall prevail.

1.2 SUMMARY

A. This Section describes the technical specifications and general instructions for the furnishing, installation, testing, handling and delivery of water, wastewater, and process gas piping and related components.

B. Pipe materials and components specified in this section include:
1. Pipe and tube
2. Fittings and couplings
3. Valve actuators
4. Identification markers
5. Installation requirements

C. Related sections
1. Division 11, Casework
2. 220529 Hangers and Supports for Plumbing Piping and Equipment
3. 224000 Plumbing Fixtures and Specialties
4. 220700 Plumbing Insulation

1.3 REFERENCES

A. The most current issue, revision, or affirmation of the references listed herein shall be used, including all addenda, errata and referenced documents.
1. Standards for Copper and Copper Alloy Tube, Pipe and Fitting
a. American Society for Testing and Materials (ASTM)
1) B88: Standard Specification for Seamless Copper Water Tube
2) B280: Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
3) B302: Standard Specification for Threadless Copper Pipe
4) B306: Standard Specification for Copper Drainage Tube (DWV)
5) B584: Standard Specification for Copper Alloy Sand Castings for General Applications
6) B813: Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
7) B819: Standard Specification for Seamless Copper Tube for Medical Gas Systems
8) B828: Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
9) B837: Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems

10) A47: Standard Specification for Ferritic Malleable Iron Castings
11) A536: Standard Specification for Ductile Iron Castings

b. American National Standards Institute/American Welding Society (ANSI/AWS)
1) A5.8: Specification for Filler Metals for Brazing and Braze Welding
2) A5.31: Specification for Fluxes for Brazing and Braze Welding
3) B2.2: Standard for Brazing Procedure and Performance Qualification
4) C3.4: Specification for Torch Brazing

c. American Society of Mechanical Engineers (ASME)
1) B1.20.1: Pipe Threads, General Purpose (Inch)
2) B16.20: Ring-Joint Gaskets for Pipe Flanges
3) B16.21: Non-metallic Flat Gaskets for Pipe Flanges
4) B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
5) B16.23: Cast Copper Alloy Solder Joint Drainage Fittings – DWV.
6) B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500, and 2500
7) B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV
8) B31.1: Power Piping
9) A13.1: Scheme for the Identification of Piping Systems

d. National Fire Protection Association (NFPA)
1) 54: National Fuel Gas Code
2) 99: Health Care Facilities
3) 70: National Electrical Code

e. Compressed Gas Association (GCA)
1) CGA G-6.2: Commodity Specification for Carbon Dioxide
2) CGA G-7.1 Commodity Specification for Air
3) CGA G-10.1: Commodity Specification for Nitrogen
4) CGA P-9: The Inert Gases: Argon, Nitrogen and Helium

2. Standards for Carbon Steel Piping and Fitting

a. American National Standards Institute (ANSI)
1) ANSI/ASME Sec. IX Welding and Brazing Qualifications (ASME Boiler & Pressure Vessel Code)
2) ANSI/ASME B1.20.1 General Purpose (Inch) Pipe Threads
3) B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy
4) B16.11 Forged Steel Fittings, Socket-Welding and Threaded
5) B16.25 Buttwelding Ends
6) ANSI/ASME B31.1 Power Piping

b. American Society for Testing and Materials (ASTM)
1) A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
2) A105 Forgings, Carbon Steel, for Piping Components
3) A181 Forgings, Carbon Steel for General Purpose Piping
4) A307 Carbon Steel Externally Threaded Standard Fasteners

1.4 DEFINITIONS

A. CPVC: Chlorinated polyvinyl chloride plastic

B. EPDM: Ethylene-propylene-diene terpolymer rubber

C. HDPE: High density polyethylene plastic

D. PE: Polyethylene plastic

E. PP: Polypropylene plastic

F. PTFE: Polytetrafluoroethylene plastic

G. PVC: Polyvinyl chloride plastic

H. PVDF: Polyvinylidene fluoride plastic

I. SS: Stainless steel

J. TFE: Tetrafluoroethylene

1.5 SUBMITTALS

A. Documentation Requirements
1. Submitted documentation shall be complete and consistent to provide a written record to prove that the pipe, tube and components conform to the specifications and intent of the design.

B. Shop Drawings
1. Refer to paragraph 1.17 of Section "General Mechanical Requirements" for procedural requirements and also to the other related documents referenced in paragraph 1.1 of this section.
2. Submittal packages shall include for all equipment (where applicable):
   a. Component drawings including sections, dimensions, exploded parts drawing, and parts identification
   b. Pipe dimensions, wall thickness, pressure ratings at temperature
   c. Pressure and temperature classification
   d. End connection details
   e. Welders' Qualifications
   f. Thermoplastic heat fusion installer certifications by manufacturer
   g. Internal finish specifications
   h. External finish specifications
   i. Control valve pressure and flow characteristics including Cv values as tested by the manufacturer
   j. Shop Drawings detailing pipe anchors, alignment guides, and expansion joints and loops

C. Installation check procedures

D. Testing and Pre-Start-up Procedures

E. Closeout Submittals
1. Revise final drawings, to incorporate all mark-ups and notes in the shop drawings to reflect the specific installation
2. Submit certificates of inspections and test reports
3. Submit weld reports.
4. Operation and Maintenance Manual
5. Equipment certificates and warranties

1.6 CERTIFICATIONS

A. Weld stamps shall be traceable back to the individual installer's training and certification records.

B. Factory-trained and certified installers shall install thermoplastic piping. Installers of heat fusion thermoplastic joints shall hold current certifications in the installation and fusion methods from the respective pipe manufacturers.

1.7 DELIVERY STORAGE AND HANDLING

A. Packing/Shipping/Handling/Unloading
1. ings and valves with end caps and in individual plastic bags, properly sealed.

B. Storage and Protection
1. ain packaging, caps and seals on all materials until ready for immediate installation. Wood or cloth plugs or any type of tape are not acceptable and shall not be used.

1.8 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15400 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping installer for insulation application.

C. Coordinate installation and testing of electric heat tracing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the manufacturers specified.

B. Bronze Valves
1. Conbraco Industries, Inc.; Apollo Division
2. Crane Co.; Crane Valve Group; Crane Valves
3. Watts Industries, Inc., Water Products Division
4. Grinnell Corporation
5. Jamesbury, Inc.
6. NIBCO, Inc.
7. American Valve, Inc.
8. Process Development and Control
9. Milwaukee Valve Company
10. Tyco International Ltd.
11. Approved equal

C. Polypropylene Valves
1. George Fisher
2. Enfield
3. Orion
4. Asahi America
5. Nibco, Inc.

6. Approved equal

D. Stainless Steel Valves
1. Neles-Jamesbury
2. Worcester
3. Jordan Steriflow
4. ITT
5. Alfa Laval
6. Nupro
7. Swagelock
8. Parker
9. Approved equal

E. Piping and Fittings
1. Polypropylene, CPVC Drainage Pipe and Fitting
   a. George Fisher
   b. Enfield
   c. Chemtrol
   d. Approved equal
2. Copper Tubing and Fittings
   a. Mueller Industries
   b. Howell Metal Company
   c. Cerro Copper Tube Co.
   d. Elkhart Products
   e. Nibco Inc.
   f. Approved equal
3. Dielectric Unions and Flanges
   a. Watts Industries Co.
   b. Epco Sales Inc.
4. Gaskets
   a. Garlock Inc.
   b. Flexitallic
   c. Melrate Gasket

2.2 PIPE MATERIALS SPECIFICATION INDEX

A. The following table summarizes the pipe classes specified in this Section. Refer to the respective Pipe Class data sheets for detailed requirements.

Service	Code	Maximum Service Operating Limits		Class	Pipe Material
		(psig)	Temp (°F)		
Indirect Waste	IW	Gravity	250	A10	Copper
Hot and Cold Water	HW/CW	80	250	A10	Copper
Tempered Water	TW/EW	80	250	A10	Copper
Natural Gas	G	50	70	A11	Carbon Steel
Laboratory Compressed Air	CA	125	120	A13	Copper
Carbon Dioxide	CO2	125	120	A14	Copper
Laboratory Vacuum	VAC	29" HG	120	A15	Copper
Vacuum Exhaust	VE	50	120	A17/A10	Galvanized Steel/Copper
Lab Vent	LV	Gravity	140	D12	Polypropylene
Lab Waste	LW	Gravity	140	D12	Polypropylene
Lab Waste (Plenum Rated)	LW	Gravity		D13A	PVDF

Service	Code	Maximum Service Operating Limits		Class	Pipe Material
		(psig)	Temp (°F)		
Lab Waste (Plenum Rated)	LV	Gravity		D13A	PVDF

General Pipe Spec Notes:

1. Each valve type shall be the product of a single manufacturer. Each system shall be provided with valves as required by code and shown on the drawings. And shall be installed to facilitate operation, replacement and repair.
2. Provide access panels for concealed valves behind non-removable ceilings or walls.
3. Provide shut-off valves on supply piping to individual pieces of equipment.
4. Provide pipe dope, Teflon tape, wax rings, neoprene gaskets and other jointing compounds as required by best standard practice and only on service as recommended by manufacturer.
5. Apply putties and jointing compounds for plumbing fixtures and trim as recommended by manufacturers.
6. Valves on insulated piping systems shall be equipped with extended handles to accommodate insulation thickness.

A10: COPPER WATER TUBE

PIPE CLASS A10	½" to 3"	4" and Larger
PIPE	Seamless copper water tube, drawn temper, Type L. ASTM B-88. See Note 1.	Seamless copper water tube, drawn temper, Type L. ASTM B-88. See Notes 2 & 5.
FITTINGS	Wrought copper, solder-joint. ASME B16.22	Ductile iron coupling with copper alkyd enamel paint coating, ASTM A-536. Grade "E" EPDM elastomer gasket, ASTM D-2000. Equal to Victaulic Style 606 coupling. ASTM B-75 copper alloy fittings. ASTM B-584 grooved end cast bronze fittings for 6" pipe size.
JOINTS	ASTM B-32 solder filler material, Alloy Sb5 "95/5." ASTM B-813 liquid or paste flux. Soldering procedures shall comply with ASTM B-828.	Rolled groove prepared and assembled in accordance with manufacturer instructions.
MECHANICAL JOINTS	Cast copper alloy unions, hexagonal stock with ball-and-socket joint, solder joint ends. ASME B16.18.	ANSI Class 150 flange adapter equal to Victaulic Style 641 for connections to flanged equipment. ANSI B16.1 dimensions.
VALVES		
GATE	Use ball valve.	Use ball valve.
BALL	All bronze, 3 piece, full port, PTFE seats, solder end connections. 600 psig WOG. Apollo 82-200, Milwaukee BA-350, Watts B-6801.	Class 125, cast iron body, epoxy coated. Full port, flanged ends, stainless steel ball and stem. ANSI B16.1 flange dimensions. Watts G-4000-FDA series.
CHECK	Bronze body and clapper, solder ends, 200 WOG. Jenkins 4093, Milwaukee 1509, Stockham B-309.	Iron body, bronze mounted, flanged ends, 200 WOG. Jenkins 624-C, Milwaukee F-2974-M, Stockham G-931.
BALANCING	All bronze, 2 piece, RPTFE seats, solder end connections. 600 psig WOG. Apollo 70-100, Milwaukee BA-150, Watts B-6001. CamLock handle.	Cast iron lug body butterfly valve. Bronze disc, replaceable EPT liner, stainless steel stem, 200 psig CWP.
DRAIN	All bronze, 2 piece, RPTFE seats, thread x solder end connections. 600 psig WOG. Apollo 70-100, Milwaukee BA-150, Watts B-6001. Hose thread adapter with cap and chain.	

Notes:
1. Below grade water piping 3" and smaller shall be Type K copper with bituminous coating and copper brazed joints, BCuP filler alloy. ANSI/AWS A5.8. Procedures shall be per ANSI/AWS B2.2.
2. Below grade water piping 4" and larger shall be ductile iron cement lined Class 52 piping with push-on joints.
3. Contact between dissimilar metals shall be made with di-electric couplings or di-electric flanges. Contact between ferrous stud bolts and bronze flanges shall be electrically insulated with non-metalic washers.

A11: NATURAL GAS

PIPE CLASS A11 ITEM	2" AND SMALLER	2½" AND LARGER
Pipe	Schedule 40 Carbon Steel ASTM A53 Grade B, A106 Grade A or A120.	Schedule 40 carbon steel ASTM A53 Grade B, A106 grade A or A120.
Fittings	Screwed malleable iron 125 psi.	Butt weld carbon steel Schedule 40, A234.
Joints		
Unions	Screwed 150# Malleable Iron A105 Grade II.	Use flanges.
Flanges	Class 125 Raised face, screwed, A105.	Class 150 raised face weld neck A105 ASTM A181, Grade I. Class 150 flat face for cast iron valve.
Flange Gaskets	1/16" red rubber, wire inserted. Class 150 raised face and Class 125 flat face gasket.	
Flange Bolts		
Valves Plug/Gas Cock	Use ball valve.	Iron body, greasable and lubricated tapered plug, flanged end, 175 working pressure. Nordstrom 143, Serck Audco LSW-133-GG, Walworth.
Ball	Bottom loaded pressure stem. Valve rated at 600 psi WOG. Watts B-6000-UL, Apollo Model 70-10x-07, or equal. Nibco 585-70	
Emergency Gas Shut-Off Cabinet	Zurn Accudoor custom valve box with brushed stainless finish. Flush door, glass panel, labeled "safety gas shutoff valve," T handle locks. Furnish and install approved ball valve as specified above.	
Check	150# class, bronze swing check valve. Aluminum disc, screwed cap, and threaded ends. Approved equal to Eclipse Inc. Series 1000. Nibco	
Pressure Regulators	Fisher Regulator 113 Series or equal.	
Gas Meter	By local utility.	

NOTES:
1. Provide two wrenches for each gas cock size.
2. All welders for gas piping must be certified per the requirements of this Section.
3. Gas piping installed inside concrete walls or block partitions shall be protected for corrosion and in accordance with IFGC

A13: LABORATORY AIR

PIPE CLASS A13 ITEM	½" to 2"	2 ½" and Larger
Pipe	Seamless copper tube, drawn temper, ACR Type L. ASTM B-280. (See Note 1.)	Seamless copper tube, drawn temper, ACR Type L. ASTM B-280. (See Note 1.)
Fittings	Wrought copper, solder-joint. ASME B16.22. (See Note 1.)	Wrought copper, solder-joint. ASME B16.22. (See Note 1.)
Joints	ANSI/AWS A5.8 brazing filler material, BCuP series. No flux. (See Note 2.)	ANSI/AWS A5.8 brazing filler material, BCuP series. No flux. (See Note 2.)
Unions	Cast copper alloy unions, hexagonal stock with ball-and-socket joint, solder joint ends. ASME B16.18. (See Note 1.)	Use flanges.
Flange	Class 150 flange, ANSI B16.24. 210 psi wog, 150°F, ANSI B16.1 flange dimensions (See Note 1.) (Note: Flange and bolt insulating kits should be used when flanges are dissimilar metals)	Class 150 flange, ANSI B16.24. 210 psi wog, 150°F, ANSI B16.1 flange dimensions (See Note 1.) (Note: Flange and bolt insulating kits should be used when flanges are dissimilar metals)
Flange Gaskets	1/8" thick fiber free neoprene, full face or ring type for rigid face flanges. Garlock No. 7986, or equal.	1/8" thick fiber free neoprene, full face or ring type for rigid face flanges. Garlock No. 7986, or equal.
Flange Bolts	Studs: Continuous threaded studs, carbon steel hex, head bolts, ASTM A307, Grade B Nuts: Heavy hex, carbon steel, ASTM A563, Grade A (Note: Isolated bolts and nuts from flanges by means of insulating kits)	Studs: Continuous threaded studs, carbon steel hex, head bolts, ASTM A307, Grade B Nuts: Heavy hex, carbon steel, ASTM A563, Grade A (Note: Isolated bolts and nuts from flanges by means of insulating kits)
Valves (See Note 1.)		
Ball	All bronze, 3 piece, full port, PTFE seats, stainless steel ball and stem, solder end connections. 600 psig WOG. Apollo 82-200-10-57, Worcester valve model X4-16-TT, Nibco S-595-Y oxygen cleaned, Watts B-6801-SS-OC.	All bronze, 3 piece, full port, PTFE seats, stainless steel ball and stem, solder end connections. 600 psig WOG. Apollo 82-200-57, Worcester valve (O_2 service) model X41-6TT-151 supply ANSI flanges, Chemetron model 77 K-tube extension.
Check	Class 125, bronze body, bronze disc, solder end connections. See Note 2. Milwaukee 1509, Jenkins 4093, Stockham B-309. Nibco 413Y	Class 125, cast iron body, bronze disc, flanged end connections. ANSI B16.1 flange dimensions. (See Note 2.) Milwaukee F-2974.
Pressure Regulator (Mains)	Bronze body, bronze piston and cylinder. BUNA "N" seat elastomer disc and stack. Cash Acme B Series with wheel handle.	
Pressure Regulator (Point-Of-Use)	Bronze body, stainless steel piston and cylinder. Concoa Series 400.	
Relief Valve		

NOTES:

1. Valves, fittings, components and each length of tube shall be factory cleaned per the applicable pipe standard. They shall be permanently labeled and delivered plugged, capped, bagged or otherwise sealed. Plug caps or other seals shall remain in place until final assembly.
2. Joints and piping shall be continuously purged with a positive flow of Grade M, CGA Pamphlet G-10.1 oil free, dry nitrogen per ANSI/AWS B2.2 procedures.
3. Valves shall be by a single manufacturer.
4. Provide mechanical joint connections to all equipment such as pumps, compressors, manifolds, etc.
5. Contact between dissimilar metals shall be made with dielectric couplings or dielectric flanges. Contact between ferrous and bolts and bronze or copper flanges shall be electrically insulated with non-metallic washers.

A14: CARBON DIOXIDE

PIPE CLASS A14 ITEM	½" to 2"	2 ½" and Larger
Pipe	Seamless copper tube, medical gas, drawn temper, Type L. ASTM B-819. (See Note 1.)	Seamless copper tube, medical gas, drawn temper, Type L. ASTM B-819. (See Note 1.)
Fittings	Wrought copper, solder-joint. ASME B16.22. (See Note 1.)	Wrought copper, solder-joint. ASME B16.22. (See Note 1.)
Joints	ANSI/AWS A5.8 brazing filler material, BcuP series. No flux. (See Note 2.)	ANSI/AWS A5.8 brazing filler material, BCuP series. No flux. (See Note 2.)
Unions	Cast copper alloy unions, hexagonal stock with ball-and-socket joint, solder joint ends. ASME B16.18. (See Note 1.)	Use flanges.
Flanges	Class 150 flange, ANSI B16.24. 210 psi wog, 150°F, ANSI B16.1 flange dimensions (See Note 1.) (Note: Flange and bolt insulating kits should be used when flanges are dissimilar metals)	Class 150 flange, ANSI B16.24. 210 psi wog, 150°F, ANSI B16.1 flange dimensions (See Note 1.) (Note: Flange and bolt insulating kits should be used when flanges are dissimilar metals)
Flange Gaskets	1/8" thick fiber free neoprene, full face or ring type for rigid face flanges. Garlock No. 7986, or equal.	1/8" thick fiber free neoprene, full face or ring type for rigid face flanges. Garlock No. 7986, or equal.
Flange Bolts	Studs: Continuous threaded studs, carbon steel hex, head bolts, ASTM A307, Grade B Nuts: Heavy hex, carbon steel, ASTM A563, Grade A (Note: Isolated bolts and nuts from flanges by means of insulating kits)	Studs: Continuous threaded studs, carbon steel hex, head bolts, ASTM A307, Grade B Nuts: Heavy hex, carbon steel, ASTM A563, Grade A (Note: Isolated bolts and nuts from flanges by means of insulating kits)
Valves (See Note 1.)		
Ball	All bronze, 3 piece, full port, PTFE seats, stainless steel ball and stem, solder end connections. 600 psig WOG. Apollo 82-200-10-57, Worcester valve model X4-16-TT, Nibco S-595-Y oxygen cleaned, Watts B-6801-SS-OC.	All bronze, 3 piece, full port, PTFE seats, stainless steel ball and stem, solder end connections. 600 psig WOG. Apollo 82-200-57, Worcester valve (O_2 service) model X41-6TT-151 supply ANSI flanges, Chemetron model 77 K-tube extension.
Check	Class 125, bronze body, bronze disc, solder end connections. See Note 2. Milwaukee 1509, Jenkins 4093, Stockham B-309. Nibco 413Y	Class 125, cast iron body, bronze disc, flanged end connections. ANSI B16.1 flange dimensions. (See Note 2.) Milwaukee F-2974.
Regulators	Watersaver Faucet Model L3173-366-158WS. Refer to details.	
Relief Valves		

NOTES:

1. Valves, fittings, components and each length of tube shall be factory cleaned and suitable for medical oxygen service in accordance with CGA Pamphlet G-4.1. They shall be permanently labeled and delivered plugged, capped, bagged or otherwise sealed. Plug caps or other seals shall remain in place until final assembly.
2. Brazers shall be qualified in accordance with the requirements of NFPA 99. Joints and piping shall be continuously purged with a positive flow of Grade M, CGA Pamphlet G-10.1 oil free, dry nitrogen per ANSI/AWS B2.2 and NFPA 99 procedures.
3. Valves shall be by a single manufacturer.
4. Provide mechanical joint connections to all equipment such as pumps, compressors, manifolds, etc.
5. For all medical gas installations, provide lockable valves on all control valve installations.
6. Contact between dissimilar metals shall be made with dielectric couplings or dielectric flanges. Contact between ferrous and bolts and bronze or copper flanges shall be electrically insulated with non-metallic washers.

A15: LABORATORY VACUUM

PIPE CLASS A15 ITEM	½" to 2"	2 ½" and Larger
Pipe	Seamless copper tube, drawn temper, Type L. ASTM B-88.	Seamless copper tube, drawn temper, Type L. ASTM B-88.
Fittings	Pressure wrought copper, solder-joint, drainage pattern. ASME B16.22.	Pressure wrought copper, solder-joint, drainage pattern. ASME B16.22.
Joints	ANSI/AWS A5.8 brazing filler material, BcuP series	ANSI/AWS A5.8 brazing filler material, BCuP series.
Unions	Cast copper alloy unions, hexagonal stock with ball-and-socket joint, solder joint ends. ASME B16.18.	Use flanges.
Flanges	Class 150 flange, ANSI B16.24. 210 psi wog, 150°F, ANSI B16.1 flange dimensions. (Note: Flange and bolt insulating kits should be used when flanges are dissimilar metals)	Class 150 flange, ANSI B16.24. 210 psi wog, 150°F, ANSI B16.1 flange dimensions. (Note: Flange and bolt insulating kits should be used when flanges are dissimilar metals)
Flange Gaskets	1/8" thick fiber free neoprene, full face or ring type for rigid face flanges. Garlock No. 7986, or equal.	1/8" thick fiber free neoprene, full face or ring type for rigid face flanges. Garlock No. 7986, or equal.
Flange Bolts	Studs: Continuous threaded studs, carbon steel hex, head bolts, ASTM A307, Grade B Nuts: Heavy hex, carbon steel, ASTM A563, Grade A (Note: Isolated bolts and nuts from flanges by means of insulating kits)	Studs: Continuous threaded studs, carbon steel hex, head bolts, ASTM A307, Grade B Nuts: Heavy hex, carbon steel, ASTM A563, Grade A (Note: Isolated bolts and nuts from flanges by means of insulating kits)
Valves Ball	All bronze, 3 piece, full port, PTFE seats, stainless steel ball and stem, solder end connections. 600 psig WOG. Apollo 82-200, Chemetron Model 77 with tube extension, Worcester Model X416TT-TE, Nibco Valve Co. S-595-Y-66	To 4" Apollo 82-200, Chemetron Model 77, Worcester Valve X416TT-151 with flanges.
Check	Class 125, bronze body, bronze disc, solder end connections. Milwaukee 1509, Jenkins 4093, Stockham B-309. Nibco 413Y	Class 125, cast iron body, bronze disc, flanged end connections. ANSI B16.1 flange dimensions. Milwaukee F-2974. Nibco F408W

NOTES
1. Valves shall be by a single manufacturer.
2. Provide mechanical joint connections to all equipment such as pumps, compressors, manifolds, etc.
3. Contact between dissimilar metals shall be made with dielectric couplings or dielectric flanges. Contact between ferrous stud bolts and bronze or copper flanges shall be electrically insulated with non-metallic washers.

A17 VACUUM EXHAUST

PIPE CLASS A17 ITEM	3" AND SMALLER	4" AND LARGER
Pipe	Schedule 40 galvanized steel.. ASTM A53 Grade B, A106 Grade A or A120 plain end.	Schedule 40 galvanized steel. ASTM A53 Grade B, A106 grade A or A120 plain end.
Fittings	Screwed malleable iron Class 125 galvanized.	Grooved malleable iron 125 psi galvanized.
Unions	Screwed Class 150 malleable iron A105 Grade II, galvanized.	Use flanges.
Joints	Threaded joints, flanges at equipment and valves as required (Note 1)	Flanged at flanged equipment and valves (Note 1)
Flanges	Class 125 raised face, screwed, A105 galvanized.	Class 150 raised face galvanized uniflange, ASTM A181, Grade I. Class 150 flat face for cast iron valve, 175 WOG at 150°F.
Flange Gaskets	1/16" red rubber, wire inserted, Class 150 raised face and Class 125 flat face gasket.	1/16" red rubber, wire inserted, Class 150 raised face and Class 125 flat face gasket.
Flange Bolts	Studs: Continuous threaded studs, carbon steel hex, head bolts, ASTM A307, Grade B Nuts: Heavy hex, carbon steel, ASTM A563, Grade A (Note: Isolated bolts and nuts from flanges by means of insulating kits)	Studs: Continuous threaded studs, carbon steel hex, head bolts, ASTM A307, Grade B Nuts: Heavy hex, carbon steel, ASTM A563, Grade A (Note: Isolated bolts and nuts from flanges by means of insulating kits)
Check	Horizontal swing, composition disc, all bronze, threaded ends, 200 psi WP. Milwaukee 509, Jenkins 352c, Stockham B319. Nibco T/S 413Y	Outside lever and weight swing check, IBBM for installation at no more than 45° from horizontal, flanged end, 200 psi wp. Jenkins 477-l, Stockham G931-l&W. Nibco 918W
NOTE: 1. Apply galvanized compound in accordance with manufacturer's instructions.		

D12: LAB VENT, LAB WASTE

PIPE CLASS D12 ITEM	ABOVE GRADE	BELOW GRADE
Pipe	Schedule 40 polypropylene pipe (FRPP) flame retardant manufactured to meet Schedule 40 iron pipe size dimensional standards in accordance with ASTM D2122, Section 4 and 7.	Schedule 40 polypropylene pipe (PPNO) non flame retardant black Type I.
Fittings	DWV pattern flame retardant Schedule 40 fittings based on laying length dimensions in ANSI B16-12. Wall thickness shall conform to ASTM D2122, Section 4.	DWV pattern flame retardant Schedule 40 fittings based on laying length dimensions in ANSI B16-12. Wall thickness shall conform to ASTM D2122, Section 4.
Joints	Fusion method with fusion coils or fixed fusion fittings fabricated in accordance with the manufacturer's recommendations. Joints made between PP pipe and dissimilar materials shall be joined with proper adapters and transition fittings according to manufacturer's recommendations.	Fusion method with fusion coils or fixed fusion fittings fabricated in accordance with the manufacturer's recommendations. Joints made between PP pipe and dissimilar materials shall be joined with proper adapters and transition fittings according to manufacturer's recommendations.
Acceptable Manufacturers	Refer to Section 2.1	

NOTES:

1. Interior lab waste and vent branch piping under lab benches shall be made with FRPP pipe and mechanically joined DWV chemical waste pipe fittings.

D13A: LAB WASTE AND VENT (PLENUM RATED).

PIPE CLASS D-13A ITEM	ABOVE GRADE	BELOW GRADE
PIPE	Schedule 40 Flame Retardant Polyvinylidene Fluoride Piping, (PVDF). Pipe shall be rated for use in return air plenums per UL and FM tests for smoke and flame spread. The PVDF material shall conform to ASTM D3222. The Piping shall be manufactured to meet schedule 40 Iron Pipe Size Dimensional Standards In Accordance With ASTM D 2122, Section 4 & 7. The pipe shall be marked with UL Classification to indicate compliance with UL 723 (ASTM E84).	Schedule 40 Flame Retardant Polyvinylidene Fluoride Piping, (PVDF). The PVDF material shall conform to ASTM D3222. The Piping shall be manufactured to meet schedule 40 Iron Pipe Size Dimensional Standards In Accordance With ASTM D 2122, Section 4 & 7.
FITTINGS	DWV Pattern Flame Retardant Schedule 40 Fittings Based On Laying Length Dimensions In ANSI B16-12. Wall Thickness Shall Conform To ASTM F1673 and ASTM E84	DWV Pattern Schedule 40 Fittings Based On Laying Length Dimensions In ANSI B16-12. Wall Thickness Shall Conform To ASTM F1673 and ASTM E84
JOINTS	Fusion Method equal to Orion socket fusion system conforming to ASTM 2657. Fittings Fabricated In Accordance With The Manufacturer's Recommendations. Joints Made Between PVDF Pipe And Dissimilar Materials Shall Be Joined With Proper Adapters And Transition Fittings According To Manufacturer's Recommendations.	Same As Above Grade
Accepted Manufacturers	Refer to Section 2.1	

NOTES:

1. Installation, including support spacing, compensation for expansion and contraction, and joining shall be in compliance with manufacturer's recommendations.

PART 3 - EXECUTION

3.1 SPECIAL RESPONSIBILITIES

A. Coordinate with work of other Sections in executing work of this Section.

3.2 INSTALLERS

A. The installation of laboratory process piping systems requires high quality of workmanship, quality control and documentation. The Contractor is fully responsible for quality control documentation related to the experience, certifications, training, and field and shop procedures utilized.

B. Maintain a continuous record of field or shop-installed or fabricated elements of the system to the individual(s) performing the Work.

3.3 LABORATORY PIPING INSTALLATION

A. Material Handling and Protection in Field
   1. Confirm that the packaging of sub-assemblies or components is undamaged and that all tube ends are sealed and capped.
   2. All pipe and fittings shall be clean when installed. Each length of pipe shall be free of all grease, oil, loose mill scale or other foreign matter. All piping that is clean when received shall be kept clean. Any piping that is dirty or contaminated shall not be used.
   3. Protective plugs or caps shall not be removed until just prior to installation. Just prior to completion of the day's work, all open ends of pipe, tubing, and fittings shall again be plugged or capped. Any pipe, tubing, or fittings exposed to the weather during installation shall be capped or plugged unless fit-up work is in progress and then only that end being fit-up shall have the plug or cap removed during the fit-up period.
   4. Owner's Representative shall have the right to reject any material for installation or already installed that has been improperly stored or handled.
   5. If any job is not completed at the end of the workday all open pipe or valve ends will be capped with suitable cap capable of maintaining a 2 to 5 psig positive pressure.

3.4 JOINT CONSTRUCTION

A. Refer to Part 2 of this specification for basic piping joint construction.

B. Joints and connections shall be permanent and shall be gas- and water-tight. Jointing shall be types specified for service indicated. Joints and connections shall meet requirements of manufacturer's best recommended practice. All transitions between different piping materials shall be made using approved adapters. Adapters for transitions between two types of piping materials shall be manufactured for purpose intended.

C. Provide dielectric fittings at connections of dissimilar materials.

D. Nipples shall be same material, make and thickness as pipe with which they are used.

E. Make screw joints tight with Teflon (polytetrafluoroethylene) tape for water systems.

F. Make fusion welded joints as required by ANSI B31.1. Make changes in direction of welded pipe with welded fittings only. Bevel connections before welding, mechanically or by flame-cutting. Welding qualifications, weld records and quality control samples.

G. Connections to tanks and equipment shall be made with unions or flanges.

H. Soldered Joints: Use ASTM B813, water flushable, lead-free flux, ASTM B32, lead-free alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

I. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

J. Brazed Joints: Use ANSI/AWS A5.8 filler material, BCUP series. No flux is permitted

3.5 PIPE IDENTIFICATION

A. Provide color-coded pipe identification markers on piping installed under this Section. Pipe markers shall be snap-on laminated plastic protected by clear acrylic coating. Pipe markers shall be applied after Architectural painting where such is required.

B. Provide arrow marker with each pipe content marker to indicate direction of flow. If flow can be in either direction, use double-headed arrow marker.

C. Mains shall be labeled at points of entrance and exit from mechanical room, adjacent to each valve, on each riser, at each tee fitting, at points of entrance and exit from building, at least once in each room, and at intervals no longer than 20'.

D. In general, 2" high legend shall be used for pipe lines 4" dia. and larger, and 3/4" high legend shall be used for pipe lines 3" dia. and smaller.

E. Markers shall be Seton, Setmark, Marking Services Inc., or approved equal.

F. Color banding shall meet ANSI latest and OSHA requirements.

G. Markers shall have legends and color coding with black letters:
1. Markers are to be applied to all piping, regardless of under jacket colors per the following schedule:

Service	Legend	Background Color
Exhaust Gas	Exhaust Gas	Yellow
Natural Gas	Natural Gas	Yellow
Emergency Tempered Water	Tempered Water	Green
Laboratory Compressed Air	Compressed Air	Blue
Laboratory Vacuum	Vacuum	Green
Carbon Dioxide	Carbon Dioxide	Yellow
Lab Waste	Lab Waste	Yellow
Lab Vent	Lab Vent	Yellow

3.6 TAGS, VALVES, EQUIPMENT AND INSTRUMENTS

A. Upon completion of work, attach engraved laminated plastic tags to all valves, and instrumentation. Equipment shall bear a stamped stainless tag. Tags shall have black characters

on white face, consecutively numbered and prefixed with letter P for general valves. Tags shall bear the number used in the P&IDs for those items so marked.

B. Embossed or engraved aluminum or brass tags may be substituted if desired. Tags shall be at least 1/8" thick.

C. Tags shall be at least 1" diameter with numerals at least 3/8" high and attached by S hooks and chains.

D. Nameplates, catalog numbers and rating identifications shall be securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

E. Non-potable water outlets shall be identified with permanently attached yellow color code or 4" high triangle tag reading, "water unsafe."

F. Coordinate numbering system with existing piping tags as not to duplicate numbers.

3.7 LABORATORY WASTE AND VENT PIPING

A. Provide laboratory waste and vent piping as shown on Drawings. Laboratory vents shall extend through roof and shall increase to at least 4". Piping shall be assembled and installed without undue strains and stresses, and provision shall be made for expansion, contraction and structural settlement.

B. Interior horizontal laboratory waste piping shall be installed in practical alignment at uniform grade of at least 1/8" per foot but ¼" per foot where code dictates, and as shown on Drawings.

C. Vents from laboratory fixtures or line of fixtures (not including island bench), when connected to vent line serving other fixtures, shall be extended at least 6" above flood level rim of highest fixtures to prevent use of vent line as waste. No vent terminal shall be directly beneath door, window or other ventilating opening of building, nor shall any vent be within 12 feet horizontally of such opening.

D. Provide sleeves for pipes that pass through a wall.

E. Piping shall run straight and plumb and offsets shall be made at an angle of no less than 45.
   1. Cut pipe and square with axis of pipe. Use fine tooth hand saw and miter box, a power cutoff saw, or a plastic tubing cutter to make a precision cut.
   2. Remove all burrs remaining on end of pipe from both inside and outside surfaces.
   3. Wipe all dirt and foreign matter from end of pipe and fitting socket, using a clean, dry cloth.
   4. Vigorously sand the outside surface of the pipe where it enters the socket and the fitting socket. Use clean 60 grit abrasive cloth or paper. Clean sanded surfaces and coil with MEK (methyl ethyl ketone) or acetone.
   5. Do not handle the freshly cleaned surfaces before assembling the joint.

F. Set up joint and fuse joint according to manufacturer's recommended practice.

3.8 LABORATORY PROCESS GASEOUS SYSTEMS

A. Process gaseous systems shall be installed with minimum number of fittings. Changes in direction requiring turns of offsets with radii less than five times pipe or tubing outside diameter shall be

made by bending tubing. Bends shall be free from appreciable flattening, buckling or thinning of tube wall.

B. Tubing shall be cut accurately to system measurements obtained at site and installed without springing or forcing. Tubing shall be protected against mechanical injury in manner satisfactory to authorities that have jurisdiction.

C. Vacuum piping and component valves and fittings shall be capable of full vacuum. Threaded joints shall not be used.

3.9 CLEANING

A. Clean systems thoroughly before testing. Fixtures, equipment, pipe, valves and fittings shall be free of grease, metal cuttings, dirt and other foreign material. Remove protective covers. Fixtures (including lavatories, water closets and urinals) shall be cleaned and ready for use.

B. Repair stoppage, discoloration and damage to parts of building, finish and furnishings due to failure to properly clean piping system within Contract Price.

C. After completion of project, clean the exterior surface of equipment included in this section, including concrete residue.

D. After the completion of the work, all materials and equipment surfaces shall be cleaned and polished in accordance with the finish of the material. All chromed surfaces shall be highly polished.

E. Before the systems are tested and balanced, pipes and equipment shall be thoroughly cleaned so that no dirt, dust, or other foreign matter will be deposited in or carried through the systems.

F. Water systems shall be thoroughly flushed and cleansed of any and all deleterious materials at least once before system is placed in operation. At this time, these systems will be carefully checked for leaking and defects as hereinafter specified. An approved cleansing agent will be used in flushing.

G. At all times, keep the premises clear of undue accumulation of rubbish.

H. On completion of the work, remove all rubbish and debris resulting from this contract, and dispose of same. At any time should the general contractor be dissatisfied with the performance of clean-up responsibilities, he may elect, after proper notification, to undertake this operation and backcharge this Subcontractor accordingly.

I. All equipment shall be thoroughly cleaned and left in a satisfactory condition for proper operation at project completion.

3.10 TESTING: PIPING SYSTEMS

A. General

1. Piping systems shall be subjected to testing water or air as noted and shall hold tight at the pressure head stated for the time interval required without adding air or water. While any system is being tested, required head or pressure shall be maintained until joints are inspected.

2. Tests shall be witnessed by inspector having jurisdiction with 48-hour notice given these authorities.
3. Equipment, material and labor required for testing of various systems or part thereof shall be provided by Plumbing Contractor.

B. Vacuum System:
1. The lab vacuum system shall be tested to 150 psi with Owner's representative present, then perform rate of rise vacuum test as follows: Perform rate of rise test for vacuum per the requirements set forth by the American Vacuum Society. System P must be less than or equal to .1 ($P_{pumpout}$-P_{del}) over 1 hour; P must be less than or equal to .1 (P_{del}) over 24 hours.

C. Natural Gas Piping Systems
1. Upon completion of gas piping system or section thereof, as required, test by attaching an air compressor testing apparatus to any suitable opening and, after closing all other inlets or outlets, force air into the system until a uniform pressure of at least 10" mercury or 3 lb. gauge for a period of no less than 60 minutes for each 500 cubic feet of pipe volume without showing any drop in pressure. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device calibrated to read in increments of no greater than 1/10 lbs.
2. Test all elevated pressure gas piping at **[ ] [15 psi]** for 24 hours. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device calibrated to read in increments of no greater than 1/10 lbs.

D. Laboratory Process Gaseous Systems:
1. Compressed air, Carbon Dioxide and other lab gases piping shall be tested with nitrogen gas to 150 psi for one hour.
2. Provide a complete purity test of all laboratory gaseous piping systems. Test piping with oil-free air or nitrogen and check for cross connection. Submit testing procedures in shop drawing format for review.
    a. Retain the services for an independent testing agency to testall laboratory gases and vacuum systems.
    b. Final Purging: Introduce applicable gas for each system into respective piping system. Purge installed outlets to remove test gas. Collect samples and analyze gas at each source to identify purity level.
    c. Outflow Analysis: Collect samples and analyze gas at positive pressure outlets to confirm delivery of source gas and purity level.
    d. Particulate Sampling: Test positive pressure outlets using a 0.45-micron filter for evidence of particulate contamination. Excessive contaminants level will require additional purging.
    e. Moisture: Test positive pressure outlets for dewpoint to verify absence of moisture in piping. Do not exceed source gas dewpoint by more than 4 deg. F.
    f. The purity of the gas at six (6) random remote outlets per floor, per building shall equal the purity of the source gas.
    g. Maintain a log of systems and outlets tested. Prepare a written report including all problems and corrective action.

E. Testing Summary

System	Test Medium	Test Pressure	Test Duration
Natural Gas (low pressure)	Air	10” Mercury minimum for each 500 cubic feet of pipe volume	1 hour
Compressed Air	Oil-free Air or Nitrogen	150 psig	1 hour
Vacuum	Oil-free Air or Nitrogen	150 psig then full rate of rise vacuum test	1 hour
Special Gases	Source Gas	150 psig	1 hour
Vacuum Exhaust	Air	25 psig	1 hour

F. Defective Work: If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests shall be repeated. Repairs to piping shall be made with new material. No caulking of screwed joints or holes shall be acceptable.

G. Additional Tests
1. Provide additional tests such as smoke pressure tests as required by regulations or as directed by authorities making the inspection.
2. Provide for any repeated test as directed by the Architect, to make all systems tight as required.
3. Visual inspections of joints and valves shall be made as directed by the Architect.

END OF SECTION 221513

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221513 - LABORATORY SERVICE PIPING.DOC

SECTION 221600 - LABORATORY WASTE NEUTRALIZATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This specification section describes the technical specification and general instructions for the fabrication, furnishing, handling, delivery and installation of pH treatment equipment for wastewater.

B. Section Includes:
1. Contact basin,
2. Access way covers,
3. Neutralizing media,
4. In-line pH probes and transmitter equipment,
5. Strip-chart recorder,
6. Pour in place anti-buoyancy pads,
7. Interconnecting piping tubing and wiring.

C. Related Sections
1. Division 3 Section “Cast In Place Concrete”
2. Section 221513 Laboratory Service Piping

1.3 DEFINITIONS

A. pH – A logarithmic scale ranging from 0 to 14 indicating the level of acidity or alkalinity of a solution. Specifically, pH is determined by calculating the negative logarithm of the hydrogen ion (H+) concentration in solution expressed in moles per liter. A pH level of 7.0 at 25°C (77°F) is considered neutral. Values below 7.0 are considered acidic and values above 7.0 are alkaline (basic).

B. Neutral – Refers to the state of a solution when the concentration of hydrogen (H+) ions in solution is equal to the hydroxide ion (OH-) concentration.

C. Local Sewer Authority – The regulatory authority (local, state or otherwise) having jurisdiction regarding the discharge of industrial and other treated wastes into the public sewer system. Also referred to in regulations as the publicly owned (operated) treatment works (POTW).

D. Retention Period – The average period of time for untreated influent to travel from the inlet of the tank to the outlet of the tank and into the sewer system as treated effluent.

E. Reagent – A substance used to convert acidic or caustic constituents in solution to a neutral state by means of an acid/base neutralizing reaction.

1.4 SYSTEM DESCRIPTION

A. Continuous flow, pH adjustment system fabricated to treat laboratory waste effluent prior to discharge to the POTW. The neutralizing system shall minimize turbulence, promote settling, and prevent scouring of neutralizing media. Temporary backwater conditions will not cause neutralizing media to be suspended or scoured from the neutralizing system. The neutralizing system shall be comprised of two cells or chambers promoting efficient and maximum contact with the neutralizing media.

B. The neutralizing media shall be non toxic, non hazardous, and safe to handle and store without special storage devices, or under any special storage regulations.

C. The neutralizing system shall be for underground installation and shall be installed per the manufacturer's recommendations.

D. Performance Requirements
   1. Maintain effluent discharge between 5.5 and 12.0 pH or as required by Local Sewer Authority.
   2. The pH level shall be maintained by means of neutralization media and retention time within the basin.
   3. Discharge pipe shall be fitted with an approved sample port for direct sampling of the effluent by the local authority having jurisdiction.

1.5 SUBMITTALS

A. General – Submit product data, shop drawings and other related documentation in accordance with Contract Clauses and Division 1 Specification Sections.

B. Submit Product Data
   1. Product data submittal shall include all components including, but not limited to:
      a. Neutralizing retention tank(s)
      b. Neutralizing media
      c. In-line electronic pH probes and wiring
      d. Strip-chart recorder
      e. Interconnecting piping, tubing and wiring
   2. Include rated capacities, furnished specialties, and all accessories.

C. Submit Shop Drawings
   1. Submit scale drawings showing physical layout of equipment in plan view and elevation view. Include references for connection locations and clearances around and above.
   2. Submit complete wiring diagrams of all interconnecting power and control wiring. Diagrams shall indicate factory-installed wiring and field-installed wiring.
   3. Submit Material Safety Data Sheets (MSDS) of neutralizing media.

D. Submit Maintenance Data
   1. Submit maintenance instructions for inclusion in Operating and Maintenance Manual specified in Division 15 Section "Mechanical General Requirements."

E. Permits and Licenses
   1. Submit copies of all applicable paid and approved permits and licensing forms in connection with the installation of waste treatment equipment as required by the Local Sewer Authority.

1.6 QUALITY ASSURANCE

A. Manufactured equipment shall comply with the regulatory requirements of the Local Sewer Authority having jurisdiction.

B. Equipment vendor shall hold a current license to install, maintain and operate automatic pH adjustment equipment in jurisdictions requiring same.

C. The equipment vendor shall be capable of serving as Owner's agent in the application for and securing of all required DEP installation and waste discharge permits.

D. Neutralization system shall be assembled and tested at the factory prior to delivery to the site, with the exception of neutralization media, which shall be field installed at start-up.

E. Electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by an independent testing agency acceptable to the authorities having jurisdiction.

F. Assembly by Contractor shall be limited to influent and effluent connections, single power feed, signal and alarm feeds.

1.7 DELIVERY, STORAGE AND HANDLING

A. Hardware
1. All mechanical and electrical components shall be packaged for shipping as deemed appropriate by vendor. Equipment shall be stored indoors on site in accordance with vendor recommendations and away from sources of excess heat or vibration.
2. Retain shipping flange protective covers and protective coatings during storage.
3. Protect components against damage.
4. Comply with manufacturer's rigging instructions for handling.

B. Chemicals
1. Vendor shall supply complete Material Safety Data Sheet (MSDS) documentation upon chemical deliveries to the site.
2. Store and handle chemicals in accordance with vendor's recommendation and the package labeling instructions.

1.8 START-UP

A. Provide complete fill of neutralization media.

1.9 WARRANTY

A. Equipment price shall include manufacturer's standard warrantee agreement.

1.10 MAINTENANCE

A. The Contractor shall provide a twelve-month supply of strip chart recording paper.

B. The supplying vendor shall provide an option quote for an annual comprehensive service contract.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements and Drawings, provide products from one of the following:
   1. Green Turtle.
   2. Engineer approved equal.

2.2 MATERIALS, COMPONENTS AND FABRICATION

Laboratory Waste Neutralization System	
Equipment Tag	**LWNT-1**
Tank	Flat bottom, domed top, elliptical shaped ribbed tank with internal baffles, process connection nozzles and access ports. One tank required, suitable for direct burial up to 6 feet of overburden without reinforcement.
Tank Connections	6 inch inlet and outlet. All connections Schedule 40 PVC plain end pipe. Include 4 inch vent nozzle on basin top. (2) 24 inch access ports.
Tank Materials of Construction	Reinforced fiberglass. Bisphenol Type "A" epoxy vinyl ester resin and e-glass chemical resistant liner and isophthalic polyester resin and e-glass structural reinforcement layers. ASTM D 883-ULC third party tested. Cover and connections shall be air and water tight.
Neutralizing Media	Green Turtle PHIX Media 3000. Initial fill at start-up: 24 buckets.
Tank Capacity	750 gallons nominal volume.
Extension Collars	FRP. Provided by basin manufacturer. 24 inch diameter. Cut to length in field to suit finished grade elevation. Fiberglass Sinkaflex sealant.
Access Covers	Provided by basin manufacturer. 24 inch diameter cast iron covers and frame. H20 loading rated.
Internal Distribution Piping	SDR 35 PVC. Fabricated and installed by basin manufacturer.
Manufacturer/Model	Green Turtle PHIX Gravity Series, PHIX G750.
pH Sensor	Industrial quality pH glass membrane electrode with a measuring range of 0-14 pH. Automatic temperature compensation. Epoxy encapsulated preamplifier with polypropylene housing and 25 ft of five conductor shielded cable.
pH Recorder	Strip chart recorder with single pen and 2 5/16" chart width pH scaled paper. Recorder shall operate on 4-20 mA input from effluent pH. Strip paper length shall record for 31 days. 120 VAC power. Mount on main control front panel.
Effluent Monitoring Port	U-trap shall be constructed of Schedule 80 Fire Retardant Polypropylene (FRPP) designed to meet local regulatory requirements for effluent monitoring. Provide a sampling tap at the monitoring point. Inlet and outlet of the assembly shall be provided with flanged connections.
Assembly and Interconnecting Hardware	The neutralization system internals shall be completely fabricated, assembled and tested by the manufacturer for installation as a single unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine product data for connection sizes and dimensional requirements prior to installation of rough plumbing.

B. Examine rough plumbing to verify proper interface prior to installation of neutralization equipment.

C. Examine product data for requirements of concrete base dimensions. Refer to Division 3 Section "Cast-in-Place Concrete" and Division 15 Section "Mechanical General Methods."

3.2 INSTALLATION

A. Install equipment according to manufacturer's published and submitted instructions.

B. Excavate to the required depth, length and width in accordance with OSHA practices. Provide 12 inches of free clearance around the basin at the bottom.

C. Install and level a 6 inch layer of pea gravel or manufacturer approved equivalent backfill and compact to 98% Standard Proctor Density (SPD).

D. Install pour in place concrete anti-buoyancy slab as indicated on the drawing details. Ensure that anchor brackets on side of basin are covered.

E. Fill the basin with water to the level of the inlet and outlet pipes.

F. Backfill around the basin to the level of the inlet and outlet pipes will pea gravel or equivalent backfill approved by the manufacturer. Backfill in 6 to 8 inch layers and compact to 98% SPD.

G. Connect inlet and outlet piping. Complete drainage piping integrity testing to test for leaks prior to backfill.

H. Install extension collars following manufacturer's written instructions.

I. Backfill covering basin top and around extension collars in 6 to 8 inch layers and compacting to 98% SPD.

J. Pour reinforced concrete bearing slab at surface even with finished grade casting in cast iron manhole frame. Center manhole frames over extension collars. Reinforce the concrete slab for H20 loading.

K. Install electrical connections for power, controls and instrumentation. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Manufacturer representative shall inspect final installation.

B. Manufacturer shall provide representative for field supervision of equipment installation.

3.4 ADJUSTING

A. Calibrate pH probe and indicator.

3.5 DEMONSTRATION

A. Equipment manufacturer shall provide training to Owner on the normal operation, function, and maintenance of equipment and components including response to out of limit conditions, chart recorder paper replacement, and safety procedures.

3.6 COMMISSIONING

A. Perform the following checks before starting system:
   1. Laboratory waste and vent system tests complete.
   2. Check piping connections for leaks.
   3. Test operation of safety controls and devices.
   4. Provide complete fill of neutralizing media per manufacturer recommendations.

END OF SECTION 221600

N:\N0912.00\DOC\SPEC\2012_03-16_BID\221600 - LABORATORY WASTE NEUTRALIZATION SYSTEM.DOC

SECTION 222620 - PACKAGED LABORATORY VACUUM PUMP AND RECEIVER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Laboratory oil-sealed vacuum pumps.
   2. Vacuum receiver.
   3. Control panel.

1.3 DEFINITIONS

A. Actual Air: Expanded air/gas delivered to vacuum pump receiver and through pumps. Flow rate is delivered measured in acfm (actual L/s).

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. Standard Air: Free air at 68 deg F (20 deg C) and 1 atmosphere (29.92 in. Hg) before expansion and measured in scfm (standard L/s).

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   1. Wiring Diagrams: For power, signal, and control wiring.

B. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Oil-Filter Elements: Equal to 100 percent of amount installed.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED VACUUM PUMPS AND RECEIVERS

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receiver.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120-V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Automatic control switches to alternate lead-lag compressors for multi-plex pumps.
7. Instrumentation: As noted below.
8. Alarm Signal Device: For connection to building alarm system to indicate when pumps malfunction.

C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
1. Pressure Rating: Full vacuum.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: As noted below.

D. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.2 OIL-SEALED, VACUUM PUMPS

A. Equipment Tags: VP-1.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Busch.
2. Nash
3. Becker.
4. Approved equal.

C. Data Sheet:

LABORATORY OIL SEALED VACUUM PUMPS	
Equipment Tag	VP-1 (Comprising one package unit with three pumps)
Number Required	Three (3) pumps with pipe headers and control arranged to accept one future pumps without modifications to equipment.
Performance Condition	Vacuum Level at the Pump: 25" Hg Vacuum Level at the Outlet: 24" Hg
Mounting Condition Arrangement	The system shall be expandable with a fully assembled mechanical expansion module to quadruplet.
Type	Rotary vane, oil seal, duplex skid mounted unit with duplex pumps, receiver, piping and control cabinet.
Motor	Direct driven NEMA C-face TEFC nominal speed, 1800 rpm.
Vanes	Non-metallic, non-asbestos composite vanes.
Materials of Construction	Cast iron
Receiver	200 gallon capacity, ASME rated, bypass piping and valving, drain valve and vacuum indicator.
Cooling	Air cooled package.
Lubrication	Integral recirculating oil supply with oil filter. Internal oil separation shall be 4 stages of oil and smoke eliminators consisting of bulk separation, mist elimination, smoke elimination to achieve 99.9+ separation of oil and smoke particles from the exhaust gas.
Controls	The vacuum system shall be equipped with a motor control center consisting of (2) magnetic motor starters with integral overload and short-circuit protection, with pad-lockable disconnecting means; (1) low voltage control transformer with primary and secondary fuses; (2) Manual-Purge/Stop-Auto selector switches with integral pump run lights; (1) programmable controller with data interface means for adjusting system set points; (2) hour meters; (1) power distribution block for single point power feed connection; (1) 24 VDC power supply for use with an externally mounted pressure transmitter; equipment ground bus, and IEC style terminals, all housed in a NEMA 4/12 enclosure. The control panel shall be UL (UL 508) listed. [The entire motor control center shall be configured for future expansion to an automatic alternating triplex unit.] This control center shall alternate on a demand basis when the lead pump turns off, and on a timed basis to ensure approximately equal run time for each pump. All pumps will be set to come on in a cascading sequence. The controls are programmed to minimize motor starts per hour.
Electrical	Single point 460 VAC, 3 phase, 60 Hz
Valves and Connectors	Each pump shall have a built-in antisuck back valve 10 micron inlet filter, auto ball isolation valve, back pressure gauge and vibration isolators and threaded exhaust.
Sundries	Vacuum gauge, oil drain valve, flexible connectors, autopurge assembly, vertical (or horizontal) stand.
Purge System	Each pump shall be equipped with an automatic purge system to flush any gases from the pump to prevent condensation as the pump cools. Purge system shall include isolation valve and actuator, solenoid bleed valve, and controls to operate a 15-minute shutdown purge. If the supply of air or power is discontinued, the isolation valve will go in the closed position and the purge valve will go to the open position.
Start Up and Warranty	1 year by the pump manufacturer. Provide full start up service, installation, check and instruction to maintenance personnel.

LABORATORY OIL SEALED VACUUM PUMPS	
Rated Duty	325 ACFM at 25" Hg Flow Split: 50%, 50%, 50% Pump Flow: 170 acfm, 170 acfm, 170 acfm Pump Horsepower: 10 HP, 10 HP, 10 HP Pump Speed: 1,800 rpm
Acceptable Manufacturers	Busch Model TVET-3-LAB255 vertical triplex
Other:	Mounted on concrete housekeeping pad.
Notes: 1. Supply compressed air at 80 psig for controls and purge. 2. The base shall be pre-drilled, and the manifold shall be pre-piped to accept additional pumps. 3. The entire system shall be factory assembled and tested by the vacuum pump manufacturer to insure that all performance specifications are met	

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Equipment Mounting: Install vacuum pump skid on concrete base using elastomeric mounts. Comply with requirements in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
   1. Minimum Deflection: 1/4 inch (6 mm).
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange equipment so controls and devices are accessible for servicing.

C. Maintain manufacturer's recommended clearances for service and maintenance.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Laboratory Service Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

3.3 IDENTIFICATION

A. Identify general-service and components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check for lubricating oil in lubricated-type equipment.
   3. Verify that filters and piping are clear.
   4. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
   5. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
   6. Check for proper seismic restraints.
   7. Drain receiver tanks.
   8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   9. Test and adjust controls and safeties.

END OF SECTION 222620

N:\N0912.00\DOC\SPEC\2012_03-16_BID\222620 - PACKAGE LABORATORY PUMP AND RECEIVER.DOC

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Commercial, electric, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.2 PERFORMANCE REQUIREMENTS

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated.

B. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Warranty Periods: From date of Substantial Completion.
      a. Commercial, Electric, Storage, Domestic-Water Heaters:
         1) Storage Tank: Three years.
         2) Controls and Other Components: Three years.
      b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, domestic-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. American Water Heaters.
      b. Bradford White Corporation.
      c. Lochinvar Corporation.
   2. Standard: UL 1453.
   3. Storage-Tank Construction: Non-ASME-code, steel vertical arrangement.
      a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
         1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b. Pressure Rating: 150 psig (1035 kPa).
      c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   4. Factory-Installed Storage-Tank Appurtenances:
      a. Anode Rod: Replaceable magnesium.
      b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
      c. Insulation: Comply with ASHRAE/IESNA 90.1.
      d. Jacket: Steel with enameled finish.
      e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
      f. Temperature Control: Adjustable thermostat.
      g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
      h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

2.3 SOURCE QUALITY CONTROL

A. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install, electric, domestic-water heaters on domestic-water heater mounting bracket.
   1. Maintain manufacturer's recommended clearances.
   2. Arrange units so controls and devices that require servicing are accessible.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

C. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

D. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

E. Fill electric, domestic-water heaters with water.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

END OF SECTION 223300

N:\N0912.00\DOC\SPEC\2012_03-16_BID\223300 - ELECTRIC DOMESTIC WATER HEATERS.DOC

SECTION 223400 - FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following fuel-fired water heaters:
   1. Commercial, power-burner, storage, gas water heaters.
   2. Compression tanks.
   3. Water heater accessories.

1.3 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittal:
   1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1-2004, Section 7 - "Service Water Heating."

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Product Certificates: For each type of commercial water heater, signed by product manufacturer.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For water heaters to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

E. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period(s): From date of Substantial Completion:
a. Commercial, Gas Water Heaters:
1) Storage Tank: Ten (10) years.
2) Burner, Controls and Other Components: One (1) year.
b. Compression Tanks: One year(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL GAS WATER HEATERS

A. Commercial, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3 and meet ASHRAE/IESNA 90.1.
1. Manufacturers:
a. PVI Industries, Inc.
b. A. O. Smith
c. State
d. Lochinvar
e. Hubbell
f. Ruud
g. Approved equal.
2. Thermal Efficiency: 94% for gas burner.
3. Primary heat source: U-Tube water to water heat exchanger with control valve wired to tank mounted thermostat. Located at bottom half of storage tank. Receive circulated cooling jacket water from mechanical equipment to maintain tank temperature at 140 degrees F.
4. Storage-Tank Construction:

a. ASME-code steel with 150-psigworking-pressure rating.
b. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
c. Lining: Nickel plated complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed, Storage-Tank Appurtenances:
a. Anode Rod: Manufacturer standard.
b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
e. Jacket: Steel with enameled finish.
f. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
6. Venting: Sealed construction, direct-vent.
7. Temperature Control: Adjustable thermostat.
8. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
9. Special Requirements: NSF 5 construction.
10. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
11. Capacity and Characteristics:
a. Refer to plumbing plans for schedule.

2.3 COMPRESSION TANKS

A. Description: Steel, ASME and non-ASME pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
1. Manufacturers:
a. AMTROL Inc.
b. Armstrong Pumps, Inc.
c. Flexcon Industries.
d. Smith, A. O.; Aqua-Air Div.
e. Watts Regulator Co.
2. Construction:
a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling.
b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.
3. Capacity and Characteristics:
a. Refer to plumbing plans for expansion tank schedule.

2.4 WATER HEATER ACCESSORIES

A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.

B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.

C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

D. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
   1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.

E. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.
   1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.
   1. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Anchor to substrate.

D. Install gas water heaters according to NFPA 54.

E. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.

F. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

G. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.

H. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

I. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

J. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.

K. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

L. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves and to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

M. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

N. Fill water heaters with water.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets for lavatories, showers and sinks.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   6. Dishwasher air-gap fittings.
   7. Disposers.
   8. Hot-water dispensers.
   9. Water closets.
   10. Urinals.
   11. Lavatories.
   12. Commercial sinks.
   13. Kitchen sinks.
   14. Service basins.

B. Related Sections include the following:
   1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
   2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
   3. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

C. PVC: Polyvinyl chloride plastic.

D. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. LEED Submittal:
   1. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Plastic Mop-Service Basins: ANSI Z124.6.
   3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
   4. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
   5. Stainless-Steel Residential Sinks: ASME A112.19.3.
   6. Vitreous-China Fixtures: ASME A112.19.2M.
   7. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

H. Comply with the following applicable standards and other requirements specified for **lavatory and sink** faucets:
   1. Faucets: ASME A112.18.1.

2. Hose-Connection Vacuum Breakers: ASSE 1011.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
5. NSF Potable-Water Materials: NSF 61.
6. Pipe Threads: ASME B1.20.1.
7. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
8. Supply Fittings: ASME A112.18.1.
9. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Dishwasher Air-Gap Fittings: ASSE 1021.
4. Manual-Operation Flushometers: ASSE 1037.
5. Plastic Tubular Fittings: ASTM F 409.
6. Brass Waste Fittings: ASME A112.18.2.
7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Flexible Water Connectors: ASME A112.18.6.
4. Floor Drains: ASME A112.6.3.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Hot-Water Dispensers: ASSE 1023 and UL 499.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Toilet Seats: ANSI Z124.5.
10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Structural failures of unit shell.
b. Faulty operation of controls, blowers, pumps, heaters, and timers.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period for Commercial Applications: **One** year from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-Rings: Equal to **10** percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to **5** percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to **10** percent of amount of each type installed, but no fewer than **12** of each type.

4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Flushometer Tank, Repair Kits: Equal to **5** percent of amount of each type installed, but no fewer than **2** of each type.
6. Water-Closet Tank, Repair Kits: Equal to **5**> percent of amount of each type installed.
7. Toilet Seats: Equal to **5** percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawing Fixture Schedule or approved equal as product submittal to the Architect for Owner approval.

B. Lavatory Faucets:
1. American Standard Companies, Inc.
2. Chicago Faucets.
3. Kohler Co.
4. Moen, Inc.
5. Speakman Company.
6. T & S Brass and Bronze Works, Inc.
7. TOTO.
8. Zurn Plumbing Products Group; Commercial Brass Operation.

C. Sink Faucets:
1. American Standard Companies, Inc.
2. Chicago Faucets.
3. Delta Faucet Company.
4. Elkay Manufacturing Co.
5. Just Manufacturing Company.
6. Kohler Co.
7. Moen, Inc.
8. Speakman Company.
9. T & S Brass and Bronze Works, Inc.
10. Zurn Plumbing Products Group; Commercial Brass Operation.

D. Flushometers:
1. Zurn Plumbing Products Group; Commercial Brass Operation.

E. Toilet Seats:
1. American Standard Companies, Inc.
2. Bemis Manufacturing Company.
3. Church Seats.
4. Kohler Co.

F. Protective Shielding Pipe Covers:
1. McGuire Manufacturing Co., Inc.
2. Plumberex Specialty Products Inc.
3. TRUEBRO, Inc.
4. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.

G. Protective Shielding Piping Enclosures:
   1. TRUEBRO, Inc.
   2. Approved equal.

H. Fixture Supports:
   1. Josam Company.
   2. MIFAB Manufacturing Inc.
   3. Smith, Jay R. Mfg. Co.
   4. Tyler Pipe; Wade Div.
   5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
   6. Zurn Plumbing Products Group; Specification Drainage Operation.

I. Interceptors:
   1. Josam Company.
   2. MIFAB Manufacturing Inc.
   3. Smith, Jay R. Mfg. Co.
   4. Tyler Pipe; Wade Div.
   5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
   6. Zurn Plumbing Products Group; Specification Drainage Operation.

J. Dishwasher Air-Gap Fittings:
   1. Brass Craft Mfg. Co.; a Subsidiary of Masco Corporation.
   2. JB Products; a Federal Process Corporation Company.
   3. Sioux Chief Manufacturing Company, Inc.
   4. Watts Brass & Tubular; a division of Watts Regulator Co.

K. Disposers:
   1. American Standard Companies, Inc.
   2. In-Sink-Erator; a div. of Emerson Electric Co.

L. Water Closets:
   1. American Standard Companies, Inc.
   2. Kohler Co.
   3. TOTO USA, Inc.

M. Urinals:
   1. American Standard Companies, Inc.
   2. Kohler Co.
   3. TOTO USA, Inc.

N. Lavatories:
   1. American Standard Companies, Inc.
   2. Kohler Co.

O. Kitchen Sinks:
   1. Elkay Manufacturing Co.
   2. Just Manufacturing Company.

P. Service Basins:
   1. Crane Plumbing, L.L.C./Fiat Products.
   2. Florestone Products Co., Inc.
   3. Mustee, E. L. & Sons, Inc.
   4. Zurn Plumbing Products Group; Light Commercial Operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install counter-mounting fixtures in and attached to casework.

F. Install fixtures level and plumb according to roughing-in drawings.

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

N. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

P. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

Q. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.

R. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

S. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

N:\N0912.00\DOC\SPEC\2012_03-16_BID\224000 - PLUMBING FIXTURES.DOC

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following drinking fountains and related components:
   1. Drinking fountains.
   2. Fixture supports.

1.3 DEFINITIONS

A. Accessible Drinking Fountain: Fixture that can be approached and used by people with disabilities.

B. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

C. Fitting: Device that controls flow of water into or out of fixture.

D. Fixture: Drinking fountain unless one is specifically indicated.

1.4 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

B. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

C. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filter Cartridges: Equal to 100 percent of amount installed for each type and size indicated, but no fewer than 1 of each.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

A. Drinking Fountains, (DF-1):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Filtrine Manufacturing Company; Drinking Water Division.
      b. Halsey Taylor.
      c. Haws Corporation.
      d. Murdock, Inc.
      e. Oasis Corporation.
      f. Stern-Williams Co., Inc.
      g. Sunroc Corp.
   2. Description: Refer to drawing plumbing schedules.
   3. Ambient Temperature

2.2 FIXTURE SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Co.
   2. MIFAB Manufacturing, Inc.
   3. Smith, Jay R. Mfg. Co.
   4. Tyler Pipe; Wade Div.
   5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
   6. Zurn Plumbing Products Group; Specification Drainage Operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.6 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

N:\N0912.00\DOC\SPEC\2012_03-16_BID\224700 - DRINKING FOUNTAINS AND WATER COOLERS.DOC

SECTION 226119 - COMPRESSED AIR EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provision of Contract, including General and Supplementary Conditions and Division 1 specifications, apply to this section.

B. Where Paragraphs of this Section conflict with similar paragraphs of the General and Supplementary Conditions and Division 1, requirements of this Section shall prevail.

1.2 SUMMARY

A. This Specification section describes the technical specifications and general instructions for the furnishing, factory testing, handling, delivery and installation of compressed air equipment and related accessories.

B. The Contractor is responsible for preparing the detailed engineering specifications, skid fabrication drawings and wiring diagrams necessary for fabrication, quality of materials, and quality of workmanship. This specification is intended to establish minimum acceptable standards consistent with industry practice.

C. Section Includes:
1. Air compressors.
2. Receivers with integral air dryers.
3. Filters and Housings.
4. Communication interfaces.

D. Related Sections:
1. 221513 Laboratory Service Piping

1.3 REFERENCES

A. Unless noted otherwise, the most current issue, revision, or affirmation of the references listed herein shall be used, including all addenda, errata and referenced documents.

B. American Society of Mechanical Engineers (ASME)
1. Boiler and Pressure Vessel Code, Section VIII, Division 1, “Unfired Pressure Vessels.”
2. Boiler and Pressure Vessel Code, Section IX, “Welding and Brazing Qualifications.”

C. International Standards Organization (ISO) 1217, Third Edition, Displacement Compressors – Acceptance Tests.

D. Compressed Air and Gas Institute (CAGI) PNEUROP Test Code.
1. ANSI/CAGI ADF 100 “Refrigerated Compressed Air Dryers - Methods for Testing and Rating.”
2. ANSI/CAGI ADF 400 “Standards for Testing and Rating Coalescing Filters.”

E. 29 CFR: Occupational Safety and Health Act (OSHA) Part 1910, General Industry Safety and Health Regulations.

1. 1910.169 – "Air Receivers – Compressed Gas and Compressed Air Equipment."

F. American National Standards Institute (ANSI) B16.5, Pipe Flanges and Flagged Fittings.

G. National Fire Protection Association (NFPA) 70, National Electric Code (NEC).

H. National Electrical Manufacturers Association (NEMA) Standard 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 SUBMITTALS

A. Submittal Requirements
1. Refer to paragraph 1.17 of Section 15010 "General Mechanical Requirements" for procedural requirements, and also the other related documents referenced in paragraph 1.1 of this section.
2. Submitted documentation shall be complete and consistent to provide a written record to prove that the equipment, accessories and quality assurance conform to the specifications and intent of the design.

PART 2 - PRODUCTS

2.1 COMPRESSED AIR EQUIPMENT

ROTARY AIR COMPRESSOR, OIL-FREE	
Equipment Tag	AC-01, AC-02
Description	Oil-free, single stage rotary air compressor(s) with inlet pre-filter and silencer, drive motor(s), and receiver. Factory pre-assembled, pre-wired and tested for single point field connections.
Performance Conditions	Inlet: Refer to Quality Assurance Qualifications for inlet conditions. Unit shall produce discharge pressure with zero negative tolerance at rated inlet temperature within a tolerance of +/- 4% on flow and +/- 5% on specific horsepower per ISO – 1217. Outlet: Discharge air quality shall be oil-free by design: 100 psig maximum, 100°F, saturated, oil-free air.
Operating Arrangement	Duplex system with sequencing controller and receiver for automatic lead/lag operation. Integral air dryer in each unit.
Materials of Construction	Cast iron casing, stainless steel rotors, and non-asbestos gaskets.
Controls and Instrumentation	Monitoring equipment shall be integral to each compressor unit and shall include: Discharge and oil pressure indicators; outlet temperature indicators; high air inlet vacuum indicator, low oil pressure alarm, high outlet air temperature alarms, hour meter, power on light, motor overload light, auto operation light. Automatic shut-off safety devices shall include: low oil pressure, high discharge temperature, and motor overload. Emergency stop button.
Control Sequencing	Provide manufacturer-supplied sequencing control panel. Sequence control system shall start/stop, load/unload connected compressors according to field-adjustable receiver pressure settings. Compressor lead/lag sequence shall be shifted based on either manual selection, day-based sequence, or hour-based sequence. Controller shall provide selectable manual and automatic control modes. Load/unload logics.
Control Options	Automatic power outage restart.
Driver	High efficiency TEFC electric motor. Direct drive via flexible coupling.
Valves and Connectors	Per valve spec A-13. Flexible braided stainless steel connectors.
Pre-filter/Silencer	Internal to system package with 5 micron replaceable paper cartridge filter element.
Enclosure	Steel sound insulating enclosure for 65 dBA noise level rating.
Cooling	Air-cooled package.
Lubrication	Drive gear, bearings and timing gear spray lubricated. Oil pump direct-driven by main drive shaft. Integral sump. Threaded screw oil seal between gear box and rotors. Provide factory fill of bearing lubricant.
Receiver (AT-01)	240 gallon capacity. ASME rated and stamped. 150 psi working pressure. Supply relief valve (PSV), automatic drain (KV), temperature indicator (TI), pressure indicator (PI), and pressure transmitter (PT).
Electrical	460 VAC, 3ϕ , 60 Hz, single field connection. Control voltage transformer shall be provided by the manufacturer. Wye-Delta starter. Fused disconnects shall be provided under Division 16 (one per motor).
Rated Duty	Compressor Capacity: 80 scfm, each Horsepower: 20 hp, each
Start-up & Warranty	Equipment cost shall include start-up service by factory-authorized technician and twelve (12) month minimum warranty agreement for materials and workmanship.
Other	Mount on concrete housekeeping pad.

Model Number for Equality	Atlas Copco Model ZT-15 or equal.

COMPRESSED AIR REFRIGERATED DRYER AND FILTER SYSTEM	
Equipment Tag	Integral to AC-01, AC-02
Description	Refrigerated dryer. Integral to air compressor enclosure.
Performance Conditions	Inlet: 125 psig, 100 F, saturated air maximum Outlet: 35 F to 37ºF pressure dewpoint.
Maximum Working Pressure	200 psig
Materials of Construction	Stainless steel heat exchangers.
Controls and Instrumentation	Integral to AC-01, AC-02
Condenser	Air cooled.
Prefilters	N/A

COMPRESSED AIR FILTER	
Equipment Tag	F-2A, F-2B
Description	After filter
Performance Conditions	Receive air from dryer system and remove incidental particulate contamination prior to building use. Maintain ISO 8573.1 solid contaminant Quality Class
Operating Arrangement	Duplex arrangement to allow isolation of one filter for maintenance while the other remains in service.
Materials of Construction	Manufacturer standard.
Pressure Rating	150 psig maximum.
Temperature Rating	150°F maximum.
Dry Differential Pressure	1.0 psid
Wet Differential Pressure	Not applicable.
Micron Rating	.1 micron.
Drain	Not applicable.
Rated Duty	Capacity _____ scfm, each Pressure Drop _____ psi
Other	
Acceptable Manufacturer	Wilkerson AF Series or equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine product data for connection sizes and dimensional requirements prior to installation of utilities and piping.

B. Examine utilities to verify proper interface prior to installation of equipment.

C. Examine product data for requirements of concrete base dimensions. Refer to Division 3 Section “Cast-in-Place Concrete” and Division 15 Section “Mechanical General Methods.”

D. Review placement of emergency shower and eyewash equipment relative to treatment chemicals and retention tanks for compliance with OSHA regulations.

3.2 INSTALLATION

A. Install skidded components and other equipment in accordance with manufacturers’ written instructions and recommendations.

B. Install equipment on concrete bases. Set and connect units and major accessories according to manufacturers' written instructions. Install units plumb, level, and firmly anchored in locations indicated. Maintain manufacturers' recommended clearances. Orient so equipment, controls, and devices needing service are accessible.

C. Support equipment using the following vibration-control devices, unless otherwise indicated. Refer to Division 15 Section "Vibration Control."
1. Install rotating equipment, 5 hp or less with spring isolators.
2. Install rotating equipment, more than 5 hp, with concrete inertia base and spring isolators.

D. Install piping and valves in accordance with the instructions included under the respective Pipe Class. Refer to Section 15400 “Plumbing Piping.”

E. Provide pipe hangers as described under Division 15.
1. Install spring isolation hangers on piping 25 feet from rotating machine.

F. Affix instrument identification numbers, date of calibration, and next date of calibration. Labels shall be clearly visible.

G. Tag all equipment, valves, and instruments with permanent stainless steel tags bearing Drawings tag number.

3.3 CONNECTIONS

A. Install piping next to equipment and accessories to allow service and maintenance.

B. Install stainless steel braided flexible connectors to rotating equipment.

C. Connect piping to equipment and accessories with flanges, unions, and couplings as shown on Drawings and as specified under the respective pipe class.

D. Install piping for condensate drains. Pipe liquid waste drains to sanitary drainage systems. Provide air gaps at indirect waste drains with not less than 3 pipe diameters between the waste discharge and the floor drain's flood rim.

E. Ground electrical equipment.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Arrange for electric-power connections to equipment that requires power. Electric power, wiring, and disconnect switches are specified in Division 16 Sections.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to perform startup services and to demonstrate and train Owner's maintenance personnel as specified below.
   1. Train Owner's maintenance personnel on procedures and schedules related to start up and shutdown, troubleshooting, servicing, and preventive maintenance.
   2. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."
   3. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
   4. Schedule training with Owner with at least 7 days' advance notice.

3.5 PROTECTION

A. The Contractor is fully responsible for providing adequate protection to piping and components during construction and start-up.

B. Comply with manufacturer's written instructions for equipment protection.

3.6 DELIVERY, STORAGE AND HANDLING

A. Packing/Handling
   1. Prior to shipment, all openings shall be adequately sealed to protect from damage.
   2. Disassemble units only to the extent to prevent damage during shipping and to facilitate field handling.
   3. Pack each unit individually and include in packaging all necessary appurtenances and parts required for field installation.
   4. Equipment shall be match-marked or tagged to identify location.

B. Shipping
   1. Ship freight on board (FOB) job site.

3.7 SYSTEM START UP

A. Perform start-up services and training of operators by a factory-trained field service engineer. Provide travel and accommodation costs of factory personnel.

B. Start-up service of the compressed air system shall include the following:
   1. Installation checks including utility connections.
   2. System operation for routine start-up and shut-down.

3. Programming of control set points.
4. "Off-spec" set-points and response.
5. Alarm condition and response.
6. After completion of start-up testing, obtain written sign-off of system from Owner. Correct design and fabrication deficiencies responsible for unsatisfactory test results at no cost to the Owner.
7. Conduct training of system operation and maintenance for Owner personnel.

3.8 MAINTENANCE

A. Equipment vendor shall have an established field service organization and guarantee less than 12-hour response time, 24 hours per day, 7 days per week.

B. Provide one spare set of filter media cartridges for all filter types.

3.9 QUALITY ASSURANCE QUALIFICATIONS

A. Source Quality Control
1. All Electrical wiring and components shall comply with NFPA 70 (NEC)
2. Factory test certify performance to ISO1217.1996, Third Edition, Annex C or CAGI/Pneurop PN2CPC2

B. Free air delivery ratings of compressors shall be in accordance with ISO1217 or CAGI/Pneurop PN2CPTC2 Test Code.

C. Compressor equipment shall be guaranteed not to exceed a noise level of 76, dBA as measured in accordance with CAGI/Pneurop S5.1 Test Code.

D. Use the following atmospheric conditions to establish output guarantees:

1.	Barometric Pressure:	14.4 psia
2.	Inlet Pressure:	14.1 psia
3.	Ambient Temperature:	95°F
4.	Relative Humidity:	60%

3.10 WARRANTY

A. Warranty all equipment to be free of defects in material and workmanship for a period as required by Law from the date of acceptance of the functional system by the Owner, as notified in writing.

END OF SECTION 226119

N:\N0912.00\DOC\SPEC\2012_03-16_BID\226119 - COMPRESSED AIR EQUIPMENT.DOC

SECTION 226700 - REAGENT GRADE WATER SYSTEM

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Drawings and General Provision of Contract, including General and Supplementary Conditions and Division 1 specifications, apply to this section.

B. Where Paragraphs of this Section conflict with similar paragraphs of the General and Supplementary Conditions and Division 1, requirements of this Section shall prevail.

1.2 SUMMARY

A. This Specification section describes the technical specifications and general instructions for the furnishing, factory testing, handling, delivery and installation of water purification equipment for general laboratory or academic research facility reagent water.

B. The Contractor is responsible for preparing the detailed engineering specifications, skid fabrication drawings and wiring diagrams necessary for fabrication, quality of materials, and quality of workmanship. This specification is intended to establish minimum acceptable standards consistent with industry practice.

C. Section Includes:
1. Cartridge particulate filters and housings.
2. Sodium based water softeners.
3. Activated granular carbon (AGC) bed
4. Skid-mounted reverse osmosis unit.
5. Service de-ionization mixed-beds.
6. Programmable logic controller.
7. Water storage tank.
8. Repressurization pumps with variable frequency drive (VFD).
9. Ultra-violet sterilizers.
10. Sub-micron final filters.
11. Related instrumentation and controls.

D. The Contractor is responsible for providing and installing a complete functioning system meeting the performance requirements specified herein. The contractor is responsible for providing and installing all interconnecting piping, wiring (both power and control voltage) and conduit.

E. Related Sections:
1. 226710 – Pure Water Piping

1.3 REFERENCES

A. American National Standards Institute (ANSI).
1. ANSI/NSF 42 “Drinking Water Treatment Units – Aesthetic Effects”.
2. ANSI/NSF 44 “Cation Exchange Water Softeners”.
3. ANSI/NSF 53 “Drinking Water Treatment Units – Health Effects”.

B. American Water Works Association (AWWA).

C. American Society of Mechanical Engineers (ASME).

D. American Society of Mechanical Engineers (ASME), Section IX, "Welding and Brazing Qualifications."

E. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, "Unfired Pressure Vessels."

F. ASME B31.3 "Process Piping"

G. American Society for the Testing of Materials (ASTM)
1. A967 "Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts."
2. D 859 "Test Methods for Silica in Water,"
3. D 1067 "Test Methods for Acidity or Alkalinity of Water,"
4. D 1125 "Test Methods for Electrical Conductivity and Resistivity of Water,"
5. D 1068 "Test Method for Iron in Water,"
6. D 1126 "Test Methods for Hardness in Water,"
7. D 1129 "Terminology Relating to Water,"
8. D 1193 "Standard Specification for Reagent Water,"
9. D 1293 "Test Methods for pH of Water,"
10. D 1998 "Standard Specification for Polyethylene Upright Storage Tanks,"
11. D 3370 "Practices for Sampling Water,"
12. D 4453 "Practice for Handling of Ultra-Pure Water Samples,"
13. D 4517 "Test Method for Low-Level Total Silica in High-Purity Water by Flameless Atomic Absorption Spectroscopy,"
14. D 4779 "Test Method for Total, Organic, and Inorganic Carbon in High Purity Water by Ultraviolet (UV) or Persulfate Oxidation, or Both, and Infrared Detection,"
15. D 5391 "Test Method for Electrical Conductivity and Resistivity of a Flowing High Purity Water Sample,"
16. D 5542 "Test Method for Trace Anions in High Purity Water by Ion Chromatography,"
17. D 5997 "Test Method for On-Line Monitoring of Total Carbon, Inorganic Carbon in Water by Ultraviolet, Persulfate Oxidation and Membrane Conductivity Detection,"
18. D 6071 "Test Method for Low Level Sodium in High Purity Water by Graphite Furnace Atom Absorption Spectroscopy."
19. D 6161 "Standard Terminology used for Crossflow Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis Membrane Process".

H. American Welding Society (AWS)

I. College of American Pathologists (CAP)
1. "College of American Pathologists Commission on Laboratory Inspection and Accreditation: Reagent Water Specifications."

J. National Committee for Clinical Laboratory Standards (NCCLS)
1. Document C3-A3 "Preparation and Testing of Reagent Water in the Clinical Laboratory—Third Edition; Approved Guideline"

K. National Electrical Manufacturers Association (NEMA)

L. Occupational Safety and Health Act (OSHA)

M. Underwriter's Laboratories (UL)

1.4 DEFINITIONS

A. For definitions of terms used in this Section, refer to ASTM D1129, D6161 and NCCLS Document C3-A3.

1.5 SYSTEM DESCRIPTION

A. The reagent water system shall process potable water to a purity at all points of use equal to or exceeding the water quality and microbial requirements specified in:
   1. ASTM Type IV.

B. The system shall consist of packaged, modular unit treatment skids. Operation of the system shall be fully automatic.

C. Obtain a current water analysis for the water supply to be used as the system feed.

1.6 QUALITY ASSURANCE QUALIFICATIONS

A. Pure water equipment vendor shall have a minimum of five (5) years' experience in manufacturing water purification equipment and provide references for five (5) similar facilities.

1.7 SUBMITTALS

A. Submit shop drawings and submittals to Division 01.

B. Documentation Requirements
   1. Submitted documentation shall be complete and consistent to provide a written record to prove that the utilities and equipment conform to the specifications and intent of the design.

C. General
   1. Submit technical specification for all equipment including pretreatment equipment, reverse osmosis and tanks, filters, pumps, starters, heat exchangers, instrumentation and controls.
   2. Submit electrical requirements.
   3. Submit electrical data and wiring diagrams. Differentiate between factory wiring and field wiring.
   4. Submit control loop diagrams and ladder logic diagrams.
   5. Materials of construction and finishes of all product contact (wet) and non-contact parts.

D. Shop Drawings
   1. Submit shop drawings two weeks after receipt of purchase order.
   2. Submittal package shall include for all equipment (where applicable):
      a. Cover letter.
      b. Owner name and project location.
      c. Equipment name and identification number on the Drawings.
      d. Purchase order number and date.
      e. Manufacturer name and plant location.
      f. Equipment specification including utility requirements, connection sizes and types.
      g. Equipment drawings including plan and elevation, dimensions, and parts identification.

h. Equipment model, serial number, shop order number and date of fabrication.
i. Internal finish specifications.
j. External finish specifications.
k. Drawing title, number, revision number and date of issue.
l. P&ID with parts list.
m. Installation check procedures.
n. Pre-start-up check procedures.
o. Water quality test procedures.
p. Equipment weights.
q. Electrical schematics with parts list.
r. Exceptions list to specification (if applicable).
s. Exceptions list to vendor specification (if applicable).

3. Softeners: Also include the following:
   a. Overall dimensions and tolerances including access clearances.
   b. Quantity and type of softener resin including grains/gallon capacity.
   c. Material Safety Data Sheets (MSDS) for brine solution.
   d. Vessel ASME rating.
   e. Vessel interior coating.
   f. Valve specifications including solenoids, tubing and accessories.
   g. Control sequences.
   h. Regeneration flow rate and duration.
   i. Backwash flow rate and duration.
   j. NSF Certification.
4. Activated Granular Carbon (AGC) Assembly: Also include the following:
   a. Skid dimensions and tolerances.
   b. Quantity and type of activated carbon media.
   c. Vessel ASME rating.
   d. Vessel interior coating.
   e. Valve specifications including solenoids, tubing and accessories.
   f. Control sequences.
   g. Backwash flow rate and duration.
   h. Sanitization method, frequency and description.
   i. NSF Certifications.
5. Reverse Osmosis Unit: Also include the following:
   a. Membrane specifications and module assembly.
   b. Percent rejection of TDS rating.
   c. Rated permeate yield.
   d. Percent brine rejection to permeate yield.
6. Service De-ionization Mixed-Bed Units
   a. Overall dimensions.
   b. Materials of construction.
   c. Resin type and grade.
   d. Nozzle connection types, sizes and dimensioned physical locations.
7. Purified Water Tank submittals: Also include the following:
   a. Overall dimensions and tolerances for the tank and accessories.
   b. Design data including applicable codes and standards.
   c. Complete bills of materials for tank and accessories.
   d. Nozzle connection types, sizes and dimensioned physical locations.
   e. Customer nameplate.
8. Centrifugal Pumps: Also include the following:

a. Complete performance curves showing pump rate vs. discharge pressure, impeller diameter, brake horsepower, motor horsepower, hydraulic efficiency and net-positive suction head required (NPSHR).
b. Highlighted duty point of the pump on the performance curves.
c. Detailed pump and seal drawings.
d. Overall pump dimensions, including motor and frame.
e. Size, type and location of suction and discharge connections.
f. Operating weight (lbs.).
g. Passivation procedures.
h. Design and operating conditions.
i. Materials of construction.
j. Details of seal materials and design.

9. Submit Instrument Datasheets.

E. Closeout Submittals

1. General
   a. Revise final drawings and documents to incorporate all mark-ups and notes in the shop drawings to reflect the specific installation.
   b. Submit Inspection and test reports specified in "Source Quality Control" Articles in Part 2 of this Section.
2. Pre-Treatment, Primary Treatment: Provide equipment documentation as follows:
   a. User manual (3 sets): Include information to install, operate, configure, calibrate, troubleshoot and service the equipment. Include final as-built drawings, parts lists and component manufacturer literature as part of the User Manual.
   b. Manufacturing documentation (3 sets): Include safety and authorization certificates of vendor policies. Provide certificates of compliance for pressure vessel and piping materials, manufacturing, welding, surface treatment, inspection, testing and pressure vessel test report (Form U-1 for ASME) with a copy of the name plate. A certificate of compliance is defined as a description of design and manufacturing principles, practices, methods and equipment. Include boroscopic documentation.
   c. Control system validation documentation (3 sets): Include the PLC input/output listing, control valve table and a source code listing. Include change control documentation, version and media management documentation, and software development guidelines.
   d. Qualification documentation (3 sets): Include a general description of the factory acceptance test (FAT) procedures and compliance test report. General description of FAT procedures defines the objectives and describes the contents of each test and verification.
   e. Pressure vessel inspection procedure and reports.
   f. Passivation procedure and reports.
   g. Document and software review procedures.
   h. Functional software and design specification.
   i. Hardware design specification.
   j. Hardware acceptance test specification.
   k. System acceptance test specification.
3. Storage Tank: Provide equipment documentation as follows:
   a. Materials of construction.
   b. Wall thicknesses.
   c. Location of all welded joints (if applicable).
   d. Cleaning procedures and inspection report.

4. Sanitary Centrifugal Pumps: Provide equipment documentation as follows:
    a. Electropolishing procedure and inspection report.
    b. Passivation procedure and inspection report.
    c. Operating, Installation and maintenance manual.
    d. Recommended spare parts for 12 month operation.
5. Instrumentation: Provide equipment documentation as follows:
    a. Calibration certificates of all process instrumentation.

1.8 DELIVERY, STORAGE AND HANDLING

A. Packing/Handling
1. Prior to shipment, all openings shall be adequately sealed to protect from damage.
2. Disassemble units only to the extent to prevent damage during shipping and to facilitate field handling.
3. Pack each unit individually and include in packaging all necessary appurtenances and parts required for field installation.
4. Equipment shall be match-marked or tagged to identify location.

B. Shipping
1. Ship F.O.B. job site.

1.9 SYSTEM START UP

A. Perform start-up services and training of operators by a factory-trained field service engineer. Provide travel and accommodation costs of factory personnel.

B. Start-up service of the pure water system and storage tank shall include the following:
1. Installation checks including utility connections.
2. System operation for routine start-up and shut-down.
3. Programming of control set points.
4. “Off-spec” permeate dumping set-points and response.
5. Storage tank level control interfacing.
6. Alarm condition and response.
7. After system has been operating for 24 hours, collect RO water samples at hourly intervals for 8 hours. Owner analysis of samples shall meet the requirements of this specification in all respects.
8. During sampling period, check RO production rate. Production rate shall be in excess of 95% of the specified capacity.
9. After completion of start-up testing, obtain written sign-off of system from Owner. Correct design and fabrication deficiencies responsible for unsatisfactory test results at no cost to the Owner.
10. Conduct training of system operation and maintenance for Owner personnel.

C. Start-up of the purified water distribution loop shall include the following:
1. System operation for routine start-up and shut-down.
2. Programming of control set points.
3. Verification of pump rotation, speed and discharge pressure.
4. Verification of UV light intensity.
5. Collect pure water samples at use points at hourly intervals for 8 hours. Owner analysis of samples shall meet the requirements of this specification in all respects.
6. During sampling period, check flow rate and velocity through distribution loop.

7. After completion of start-up testing, obtain written sign-off of system from Owner. Correct design and fabrication deficiencies responsible for unsatisfactory test results at no cost to the Owner.
8. Conduct training of system operation and maintenance for Owner personnel.

1.10 MAINTENANCE

A. Pure water equipment vendor shall have an established field service organization and guarantee less than 12-hour response time, 24 hours per day, 7 days per week.

B. Provide one spare set of filter media cartridges for all filter types.

C. Provide as an option, the cost for a basic spare parts kit for an average 2 years operation.

D. Provide quotation for the service replacement of mixed-bed deionization units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements and Drawings, provide products by one of the following:
1. Particulate Filters, Softeners, Carbon Beds, Mixed-Bed De-ionizers
   a. Siemens/U.S. Filter
   b. General Electric
   c. Hydro
   d. Ionics
2. Reverse Osmosis Units
   a. Siemens/U.S. Filter
   b. General Electric
   c. Hydro
   d. Ionics
3. Ultra-Violet Sterilizers
   a. Aquafine
   b. Siemens/U.S. Filter
   c. Approved equal.
4. Storage Tanks (Thermoplastic)
   a. American Process Technology, Inc.
   b. Teracon
   c. Nalgene
   d. Approved Equal
5. Pumps, Sanitary
   a. Tri-Clover “Tri-Flo” Series
   b. Fristam Pumps
   c. Waukesha Pumps
   d. APV Pumps
6. Sub-micron Filters and Housings
   a. Siemens/ U. S. Filter
   b. Gelman
   c. Pall
   d. Approved equal
7. Programmable Logic Controllers

a. Allen-Bradley
b. Approved vendor standard.

B. Subject to compliance with requirements and Drawings, and unless specified otherwise, instruments and controls provided with standard approved vendor-packaged units will be considered acceptable.

C. Refer to related sections and instrument lists, valve lists, and equipment lists for explicit specifications of attached instrumentation and controls. Some instruments and controls specified may be substitutes to standard vendor components within skid-mounted units.

2.2 GENERAL FABRICATION

A. Unless otherwise noted, all skids shall be fabricated of welded carbon steel with an epoxy or PVC protective finish. All welds shall be ground smooth and polished.

B. Unless otherwise noted, all electrical enclosures shall be NEMA 12 and constructed of epoxy coated carbon steel.

C. All skids shall be assembled by the vendor to allow for single field connections for power, feed, product, drain, and control air. All electrical components shall be pre-wired, neatly arranged and run in conduit. All electrical shall be wired to an electrical enclosure.

D. Provide all interconnecting wiring (power and control) between skids back to main PLC and polishing skid. Main power to PLC-1 and polishing skid shall be provided under Electrical Division.

2.3 CARTRIDGE PARTICULATE FILTER

A. Data Sheet:

CARTRIDGE PARTICULATE FILTER	
Equipment Tag	F-101
Description	Cartridge for removal of suspended solids and turbidity.
Performance Conditions	Source Water: Municipal water supply. Provide 15 micron particulate removal.
Operating Arrangement	One (1) housing with isolation valves and manual bypass for simplex operation.
Materials of Construction	Polypropylene.
Controls and Instrumentation	None. Inlet and outlet pressure gages as shown on drawings.
Filter Media	String wound polypropylene cartridge.
Valves and Connectors	Per valve spec P-10. Threaded inlet and outlet connections.
Housing	Polypropylene. 10 inch housing.
Distribution	N/A
Electrical	None.
Compressed Air	None.
Rated Duty	3.0 gpm minimum.
Basis of Design	Equal to Siemens DI GARD series with ZHCFA series polypropylene housing.

2.4 DUPLEX WATER SOFTENERS

A. Data Sheet:

DUPLEX WATER SOFTENERS	
Equipment Tag	WS-101 and WS-102
Description	Duplex sodium based, strong acid cation water softener. Automatically regenerable. Packaged and preassembled for single point field connections. Factory preassembled, pre-wired and tested for single point field connections.
Operating Arrangement	Two (2) vessels with pipe headers and controls for a duplex parallel operation with automatic regeneration.
Materials of Construction	FRP vessels. Other components manufacturer standard.
Controls and Instrumentation	Motorized five cycle control valve with regeneration initiated based on volume throughput. NEMA 3R enclosure.
Resin	Sodium form, strong acid cation resin. 30,000 grains/cu ft capacity.
Brinemaker	Polyethylene container. Sodium chloride (NaCl) saturated solution. Injected by PVC eductor, mounted on skid.
Valves and Connectors	Per pipe Class P10.
Pressure Vessels	Non-ASME rated FRP.
Distribution	NA.
Electrical	Wall outlet.
Compressed Air	None.
Rated Duty & Connection Sizes	3.0 gpm (RO feed rating).
Certification	ANSI/NSF 44 Certified Product.
Basis of Design	Equal to Siemens PTCT Series.

2.5 ACTIVATED GRANULAR CARBON SKID

A. Data Sheet:

CARBON GRANULAR CARBON (AGC) SKID ASSEMBLY	
Equipment Tag	AGC-101
Description	General purpose carbon-filter assembly. Automatically backwashable with time clock control. Factory preassembled, pre-wired and tested for single point field connections.
Performance Conditions	>99% reduction in inlet free chlorine or chloramine level prior to RO membrane contact.
Operating Arrangement	One (1) units with pipe headers and controls for simplex operation.
Materials of Construction	FRP vessels. Other components manufacturer standard. Piping as noted on the drawings.
Controls and Instrumentation	NEMA 3R control enclosure. Frequency of backwash shall be based on timeclock. Pneumatic pilot control valves.
Filter Media	Activated Granulated Carbon & Anthracite.
Valves and Connectors	Per Pipe Class P10.
Filter Tanks	Non-ASME rated FRP.
Distribution	NA.
Electrical	Wall outlet.
Compressed Air	None.
Rated Duty	3.0 gpm (RO feed rating).
Certification	ANSI/NSF 42 and 53 Certified Product.
Basis of Design	Siemens PTCC Series.

2.6 REVERSE OSMOSIS

A. Data Sheets:

REVERSE OSMOSIS UNIT			
Equipment Tag	RO-101		
Description	Pressure assisted hyperfiltration machine designed to reject dissolved solids, bacteria and endotoxins and produce purified water. Unit shall be designed and constructed for general laboratory reagent water applications. It shall be skid mounted, and factory assembled, tested and packaged. Control shall be fully automatic.		
ITEM	SPECIFICATION		
Performance Data	Design Output	1.4 gallons per minute.	
	Feed Input	Filtered, softened, de-chlorinated city water.	
	Concentrate Flow		
	Recovery	>=75%	
	Reject	MW C/O	200 Daltons and larger.
		TDS	>99%
		Endotoxin	>2-log reduction.
	Feed Temperature	60-65°F.	
Materials of Construction	Housing	Manufacturer standard.	
	Feed Water Pipe	Pipe Class P10.	
	Permeate Pipe	Pipe Class P20.	
	Pump(s)	316 Stainless Steel, mill finish internals.	
	High Pressure Pipe	316 Stainless Steel. AWWA C606 couplings, 304 Stainless Steel with neoprene gasket.	
	Membrane Housing	Manufacturer standard.	
	Skid Frame	Carbon Steel, anti-corrosion overcoat per vendor standard design.	
	Reject Piping	Refer to P&ID.	
Inlet Filter	Mounted on skid.		
Membranes	Material	Thin Film Composite (TFC). Spiral wound.	
	Arrangement	Two-Pass design. Second stage reject recycled to first stage inlet.	
	Array	Size and number as per vendor standard design based on calculated membrane profile to meet specified performance.	
	Sanitization	Chemical	
Pump(s)	Type	Multi-staged centrifugal, high pressure pump.	
	Manufacturer	Per Vendor standard package.	
	Motor	TEFC.	
	Horsepower	Manufacturer standard.	
Controller	Description	Microprocessor with I/O display and membrane keypad.	
	Enclosure	NEMA 12	
	Location	Skid mounted.	
Electrical	480 VAC, 60 Hz, 3 phase. Control voltage transformer provided in control cabinet.		

REVERSE OSMOSIS UNIT		
Equipment Tag	RO-101	
Control Air	None.	
Inlet Water Pressure	30 psig minimum. 80 psig maximum.	
Instrumentation	Instrument	Vendor Package.
	Flow Meters	Vendor Package.
	Pressure Indicators	Vendor Package.
	Pressure Transmitters	Vendor Package.
	Conductivity	Vendor Package.
Basis of Design	Siemens Vantage M41RHP Series.	

PROGRAMMABLE LOGIC CONTROLLER PANEL	
Equipment Tag	**PLC-1: Mounted on Distribution Skid**
Description	Programmable logic controller for the control of the distribution pumps and polishing equipment. Factory pre-assembled, pre-wired and tested for single point field connections.
Enclosure	NEMA 12.
Manufacturer & Model	Allen Bradley SLC-5/04.
I/O interface	Panel View Color 1400e display with single line graphics, touch screen functions and keypad.
Wiring	Discrete input and output points shall be supplied for communication throughout the system. These discrete points shall be wired to the terminal blocks in the main control panel. The unit‘s skid wiring shall be neatly arranged and protected in conduit runs.
Components	Enclosure. Power distribution block, terminal blocks, ground block. PLC processor, chassis and power supply, 24K memory capacity PLC discrete 16 point I/O modules, 120 VAC Control voltage transformer. Fuses and circuit breakers. Variable frequency drives, 480 VAC (2 pumps). Control relays. Thermal overload protection. Elapsed run time indicator. Alarm horn. System power switch. Nameplate plaques for device identification.
Monitoring Functions	Loop flow. Pump speed. Pump voltage. Pump run elapsed time. Ultraviolet intensity monitor. Loop conductivity.
Alarm Conditions	UV intensity low. Pump fault. Loop flow low. Loop conductivity high. Loop temperature high.
Unit Shutdown Conditions	Pump fault. Loop temperature high.
Electrical	480 VAC, 3 phase, 60 Hz.
Start-up & Warranty	Equipment cost shall include start-up service by factory-authorized technician and twelve (12) month minimum warranty agreement for materials and workmanship.
Other	NA.

B. RO Source Quality Control

1. Perform factory acceptance tests to guarantee that the manufacture, functionality, and performance of the system is in accordance with approved submittal documentation package.
2. Perform factory Fabrication QC and provide the following:

a. Unit identification including unit type, drawing number, serial number, etc.
b. Drawing and diagram verification with record of as-built drawing numbers of equipment drawings, Drawings and circuit diagrams.
c. Equipment verification to certify the critical dimensions of the unit and recorded serial numbers of critical components, such as control valve, pumps safety valves, etc.
d. Control system hardware acceptance tests verifying the correct hardware has been installed, system initialized correctly and inputs and outputs (I/O) of the system are functioning correctly.
e. Process instrument calibration reports of temperature, pressure, control system, recorders, gauges and displays.
f. Inspection reports of all internal pressure vessel and piping welds and primary welds.
g. Hydrostatic test reports of pressure vessels.
h. Passivation and sanitization reports.
i. Test equipment calibration to certify the conductivity meter reference instrument and resistor systems.
j. Set printers and recorders, check motor rotation and overload device settings. Adjust flow control valves, level sensors and pressure switches.

3. Perform Operational QC and provide the following:
   a. Verification of proper connection of test utilities and the tuning of valves and recorders.
   b. Alarm testing report of all alarms on the unit.
   c. Test report of safety interlocks.
4. Perform Performance QC and provide the following:
   a. Test run reports indicating capacity and utility consumption rates. Utility connections shall be similar to those at the project site.
   b. Provide test report of unit purification capability. Report percent rejection of TDS and permeate yield for RO units.

2.7 SERVICE MIXED-BED DE-IONIZATION UNITS

A. Data Sheet:

SERVICE MIXED BED DE-IONIZERS	
Equipment Tag	SDI-101, SDI-102
Description	Mixed bed polishing units utilizing ion exchange resin.
Operating Arrangement	Two vessels with piping headers and controls for a "primary/polishing" operation.
Materials of Construction	Vendor Standard
Vessels	Non-ASME rated FRP.
Distributors	Manufacturer standard.
Resin	Virgin semiconductor grade, with Type I Anion. 25 sf per vessel.
Rated Duty	1.6 gpm minimum.
Start-up & Warranty	Equipment cost shall include start-up service by factory-authorized technician and twelve (12) month minimum warranty agreement for materials and workmanship.
Other	Include post-DI resistivity cell wired to PLC. Include post-DI resin trap.
Regeneration	Mixed bed units shall be removable for exchange at the customer site. Fixed units requiring on site regeneration utilizing acid/caustic reagents shall not be permitted.

2.8 STORAGE TANKS

A. Data Sheets:

WATER STORAGE TANK ASSEMBLY	
Equipment Tag	T-101
Description	Storage tank with level transmitter, temperature transmitter, vent filter, valves and drain. Factory preassembled, pre-wired and tested for single point field connections.
Operating Arrangement	One vessel.
Materials of Construction	Polyethylene Resin. ASTM D-1998 (0.935 – 0.965 g/cm^3 density). Comply with 21 CFR 177.1520, Olefin Polymers intended for contact with food. Long term UV stable resin.
Controls and Instrumentation	The level transmitter, temperature transmitter shall be field wired to the main control panel provided with the distribution and polishing skid unit. Refer to instrumentation spec sheets for control valve and instrument specifications.
Valves and Connectors	Pipe Class P20.
Tank	Rotationally Molded Cylindrical with dished or flat top and cone bottom. Four steel/PVC coated pipe legs. Refer to P&ID for dimensions and capacity.

Sample Valve	Tank outlet sample valve shall be pure valve equal to GF Model 319 diaphragm type.
Electrical	The level transmitter and temperature transmitter shall be field wired to the main PLC.
Nozzles	Flanged or welded. Refer to P&ID's for nozzle sizes.
Supports	Epoxy or PVC coated carbon steel saddle with four tubular steel legs. Carbon steel footpads for anchoring to floor.
Spray Ball	Include spray ball.
Rated Duty & Connection Sizes	1000 gallon nominal capacity.
Start-up & Warranty	Equipment cost shall include start-up service by factory-authorized technician and twelve (12) month minimum warranty agreement for materials and workmanship.
Other	

2.9 VENT FILTERS

A. Equipment Data:

HYDROPHOBIC FILTER	
Equipment Tag	Vent Filter
Number Required	One (1)
Mounting Condition Arrangement	Mount on vent nozzle at tank top head.
Housing	Polypropylene.
Materials of Construction	Polypropylene.
Filter Media	Hydrophobic 0.2 micron vent filter.
Controls	NA
Connections	See Drawings.
Vent/Drain	
Gaskets	Teflon/Viton (FDA approved).
Interior Finish	NA
Electrical	NA
Valves and Connectors	NA
Rated Duty	See Drawings.

2.10 CIRCULATION PUMPS

A. Data Sheet:

CIRCULATION PUMPS	
Equipment Tag	P-101, P-102
Number Required	Two. Piped in parallel for duplex operation.
Mounting Condition	Mounted on skid; both pumps mounted, with UV sterilizer and final filters. Refer to notes on Drawings for piping arrangement.
Type	Sanitary centrifugal, volute casing.
Motor	TEFC NEMA, C-faced standard
Impeller M.O.C.	316 L stainless steel 20 RA Electropolished.
Casing Materials of Construction	316 L stainless steel 20 RA, Electropolished. Exterior finish to be satin.
Casing Gasket	BUNA-N Elastomer.
Controls	From skid mounted PLC at the skid. Variable speed control. Refer to Sequence of Operation, Part III this Section.
Electrical	460/3φ/60 Hz
Mechanical Seal	Clamped sanitary seal/seat. Carbon vs. silicon carbide seal seat.
Valves and Connectors	Per pipe spec P20. Hard pipe connections with vibration isolators. Tri-Clamp port connections.
Sundries	1/2" case drain, adjustable leg kit
Start Up and Warranty	Standard manufacturing package
Rated Duty	280 ft TDH @ 88 gpm.
Horsepower	25
Acceptable Manufacturers	Alfa Laval LKP-UP-25 or equal by Tri-Clover, Waukesha, G&H.

B. Pump Source Quality Control

1. Inspect pump and bench test prior to shipment. Use manufacturer's standard mechanical and electrical integrity and performance tests.

2.11 ULTRAVIOLET STERILIZER

A. Data Sheet:

UV STERILIZER	
Equipment Tag	UV-101
Number Required	One (1)
Mounting Condition	Mounted on skid with Pumps, final filters, control valves and piping.
Type	Low pressure lamps, 185 NM.
Lamps	12.
Inlet/Outlet Connections	Refer to Drawings.
Materials of Construction	316 stainless steel.
Controls	Via PLC.
Electrical	120 VAC/10/60 Hz, wired from PLC.
Valves	Isolation, see pipe class P20.
Instrumentation	S-254 optical sensor, T-120 temperature safety control, lamp out alert, high pressure design.
Cooling Media	N/A.
Rated Duty	88 gpm minimum.
Other	Thermister, intensity monitor.
Acceptable Manufacturers	Equal to Aquafine Model CSL-12R

2.12 FLOW METER

A. FIT-101: Equal to George Fischer Vortex System in-line flow meter. DN 63 port size. PVDF body.

2.13 FINAL FILTERS

A. Data Sheet:

FINAL FILTERS	
Equipment Tag	**LF-101A/B**
Number Required	Two (2)
Mounting Condition Arrangement	Part of polishing skid, pumps
Rating	0.1 micron.
Sample Valve	See pipe class P10.
Housing	Stainless Steel.
Media	
Instruments	NA.
Connections	Flange.
Code Requirements	N/A.
Rated Duty	88 gpm minimum.
Other	

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and not less than 4 inches (100 mm) high.

B. Refer to Division 3 Section "Cast-in-Place Concrete" for reinforcement, framing, and concrete materials for 4000-psig (27.6-MPa), 28-day compressive strength.

C. Refer to Division 23 Section "Basic Mechanical Materials and Methods."

3.2 INSTALLATION

A. Install skidded components and other equipment in accordance with manufacturers' written instructions and recommendations.

B. Install equipment on concrete bases. Set and connect units and major accessories according to manufacturers' written instructions. Install units plumb, level, and firmly anchored in locations indicated. Maintain manufacturers' recommended clearances. Orient so equipment, controls, and devices needing service are accessible.

C. Support equipment using the following vibration-control devices, unless otherwise indicated. Refer to Division 15 Section "Vibration Control."
1. Install rotating equipment, 5 hp or less with spring isolators.
2. Install rotating equipment, more than 5 hp, with concrete inertia base and spring isolators.

D. Install piping and valves in accordance with the instructions included under the respective Pipe Class. Refer to Section 15400 "Plumbing Piping."

E. Provide pipe hangers as described under Division 22.

F. Affix instrument identification numbers, date of calibration, and next date of calibration. Labels shall be clearly visible.

G. Tag all equipment, valves, and instruments with permanent stainless steel tags bearing Drawings tag number.

3.3 CONNECTIONS

A. Install piping next to equipment and accessories to allow service and maintenance.

B. Connect piping to equipment and accessories with flanges, unions, and sanitary couplings as shown on Drawings and as specified under the respective pipe class.

C. Install piping for waste and reject streams. Pipe liquid waste drains to sanitary drainage or process waste systems. Provide air gaps at indirect waste drains with not less than 3 pipe diameters between the waste discharge and the floor drains flood rim.

D. Connect pneumatic tubing from compressed air supply to solenoids and actuators. Field wire actuator solenoids to PLCs and local controls as shown on Drawings.

E. Ground electrical equipment.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Arrange for electric-power connections to equipment that requires power. Electric power, wiring, and disconnect switches are specified in Division 26 Sections.

3.4 SEQUENCE OF OPERATION

A. Skidded, pre-packaged units fabricated in the factory shall undergo thorough Factory Acceptance Tests to test control sequences and calibrate instruments. Refer to Section 226700, Part 2, "Source Quality Control" for all applicable equipment.

B. Duplex Softener (WS-101, 102)
1. Control sequence for the regeneration and backwash of the softeners, a packaged skidded unit, shall be defined by the vendor. Refer to Section 226700, Part I, Submittals.
2. Initiation of softener regeneration and backwash shall be based on totalized reverse osmosis throughput.
3. The supplying vendor shall define cycle frequency, taking into account supply water hardness.

C. Activated Granular Carbon Skid (AGC-101): No control sequence.

D. Reverse Osmosis (RO-101)
1. The supplying vendor shall define all control sequences, start/stop permissives and alarm parameters. Refer to Section 226700, Part I, Submittals.
2. Control of RO-101 shall be from the control panel mounted on the reverse osmosis unit.

E. Storage Tank
1. Level
a. LIT-101 shall provide an analog signal to PLC-1 for T-101 level control.
b. LIT-101 $\geq$ 95%
1) Initiate a "T-101 Level High" alarm on PLC-1 and send a signal to RO-101 to stop.
c. LIT-101 $\geq$ 90%
1) Stop RO-101.
d. LIT-101 $\leq$ 60%
1) Start RO-101.
2. P-101/102 Safety Interlock
a. When in "automatic" mode, P-101/102 shall be operated from PLC-1 and be interlocked with T-101 level settings.
b. LIT-101 $\geq$ 30%
1) The permissive condition to start P-101/102 from PLC-1.
c. LIT-101 $\leq$ 25%
1) PLC-1 shall stop P-101/102 and initiate a "T-101 Level Low" alarm.

2) PLC-1 shall not allow automatic start of P-101/102 until the 30% level permissive is met.

F. Circulation Pumps
1. Refer to T-101 safety interlocks for details on automatic start/stop permissives from PLC-1.
2. HS-101 and HS-102 are "Local, Off, Auto" (LOA) selector switches located on the starter panel for P-101/102.
a. "Local" setting: The pumps are started and stopped from local "Start, Stop, Push" (SSP) buttons HS-101 and HS-102.
b. "Off" setting: The pumps cannot be started locally or from PLC-1.
c. "Auto" setting: The pumps are started and stopped from PLC-1 provided the T-101 level permissives are satisfied.
3. QAL-101 and QAL-102 detect line voltage to the pump motors. On low voltage, an alarm condition shall be displayed at PLC-1 and PLC-1 will shut down P-101/102.
4. Sequencing and Speed Control: In normal operating condition, both pumps shall be in "Auto" setting and shall both run (simultaneous parallel operation) at a reduced speed. PLC-1 shall monitor loop flow by means of FIT-101 mounted on the pump and polishing skid. The PLC shall adjust the speed of both pumps as if they were one pump to maintain the target loop flow of 88 gpm. If one pump were to shut down either by placing it in "Local" and stopping or due to a fault, the PLC shall adjust the speed of the remaining pump to maintain the target flow. Each pump has been selected to provide the full head anticipated to achieve the target flow rate independently. The simultaneous use is intended to (1) maintain even hours of use, (2) prevent the stagnation of water in an off-line pump casing and piping, and (3) provide uninterrupted response to loop circulation in the event of a single pump fault. The control sequence shall be capable of defaulting by user setting on the PLC to single pump operation for testing or maintenance purposes.

G. Ultra-Violet Disinfection & TOC Reduction
1. XAL-101 shall send a digital signal to PLC-1 to indicate a fault in the ultraviolet light unit.

3.5 FIELD QUALITY CONTROL

A. Sample purified water system output at user points at one-week intervals after start-up, for a period of 3 weeks. Follow ASTM D3370 procedures for sampling water. Prepare certified test reports for each required water performance characteristic. Water quality shall comply with the following standards:
1. ASTM
a. D1126
b. D859
c. D1067
d. D1068
e. D1888

3.6 CLEANING AND PASSIVATION

A. Refer to Section 226710 for Field Cleaning and Passivation Procedures.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to perform startup services and to demonstrate and train Owner's maintenance personnel as specified below.
   1. Train Owner's maintenance personnel on procedures and schedules related to start up and shutdown, troubleshooting, servicing, and preventive maintenance.
   2. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."
   3. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
   4. Schedule training with Owner with at least 7 days' advance notice.

3.8 PROTECTION

A. The Contractor is fully responsible for providing adequate protection to piping and components during construction and start-up.

B. Comply with manufacturer’s written instructions for equipment protection.

C. Restrict physical access to equipment room to individuals directly involved in equipment installation (including vendors and consultants).

END OF SECTION 226700
N:\N0912.00\DOC\SPEC\2012_03-16_BID\226700 - REAGENT GRADE WATER SYSTEM.DOC

SECTION 226710 - PURIFIED WATER PIPING

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Drawings and General Provision of Contract, including General and Supplementary Conditions and Division 1 specifications, apply to this section.

B. Where Paragraphs of this Section conflict with similar paragraphs of the General and Supplementary Conditions and Division 1, requirements of this Section shall prevail.

1.2 SUMMARY

A. This Specification section describes the technical specifications and general instructions for the furnishing, handling, delivery and installation of pipe, tube, fittings and valves to be used for purified water applications.

B. Pipe materials and components specified in this Section include:
1. Pipe and tube.
2. Fittings and couplings.
3. Valves.
4. Valve actuators.
5. Insulation Products

C. Related Sections
1. Section 226700 "Reagent Water System"
2. Section 220519 "Meters and Gages for Plumbing Piping"
3. Division 22 Sections for pipe insulation and pipe hangers.

1.3 REFERENCES

A. Unless noted otherwise, the most current issue, revision, or affirmation of the references listed herein shall be used, including all addenda, errata, and referenced documents:

B. American Iron and Steel Institute (AISI)

C. American Society of Mechanical Engineers (ASME)
1. Boiler and Pressure Vessel Code, Section VIII, Division 1, "Unfired Pressure Vessels."
2. Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
3. B31.3 "Process Piping"

D. American National Standards Institute (ANSI)
1. B16.5 "Pipe Flanges and Flanged Fittings"

E. American Society for Testing and Materials (ASTM)
1. D638 "Standard Test Method for Tensile Properties of Plastics"
2. D790 "Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials"
3. D1784 "Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds"
4. D2122 "Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings"

5. D2467 “Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80”
6. D2564 “Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems”
7. D2657 “Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings”
8. D2837 “Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials”
9. D2855 “Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings”
10. D3915 “Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Pressure Applications”
11. D4101 “Standard Specification for Propylene Plastic Injection and Extrusion Materials”
12. D6161 “Standard Terminology Used for Crossflow Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis Membrane Processes”
13. E84 “Standard Test Method for Surface Burning Characteristics of Building Materials”
14. F402 “Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings”
15. F439 “Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80”
16. F656 “Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings”

F. Occupational Safety and Health Act (OSHA)
1. 1910.254 ARC welding and cutting

1.4 SUBMITTALS

A. Documentation Requirements
1. Submitted documentation shall be complete and consistent to provide a written record to prove that the pipe, tube and components conform to the specifications and intent of the design.

B. Shop Drawings
1. Submit shop drawings two weeks after receipt of purchase order.
2. Submittal package shall include for all equipment (where applicable):
   a. Cover letter,
   b. Owner name and plant location,
   c. Component name and identification number on the P&ID’s,
   d. Purchase order number and date,
   e. Manufacturer name and plant location,
   f. Component drawings including sections, dimensions, exploded parts drawing, and parts identification,
   g. Quantity (units, feet, meters or number of lengths),
   h. Pipe dimensions, wall thickness, pressure ratings at temperature.
   i. Component model, serial number, shop order number and date of fabrication,
   j. Heat fusion procedures for thermoplastic pipe,
   k. Thermoplastic heat fusion installer certifications by manufacturer,
   l. Drawing title, number, revision number and date of issue,
   m. Control valve pressure and flow characteristics including Cv values as tested by the manufacturer.
   n. Shop Drawings detailing pipe anchors, special pipe support assemblies, alignment guides, and expansion joints and loops.
   o. Detailed isometric diagrams of all loop distribution systems.

C. Installation check procedures,

D. Pre-Start-up Check Procedures,

E. Exceptions list to specification (if applicable),

F. Exceptions list to vendor specification (if applicable).

G. Samples
   1. Submit sample of butt fused joint for each type of thermoplastic pipe.
   2. Submit sample of butt fused, ridge and bubble free joint for each type of thermoplastic pipe.

H. Closeout Submittals
   1. General
      a. Revise final drawings, isometrics and documents to incorporate all mark-ups and notes in the shop drawings to reflect the specific installation.
      b. Submit certificates of inspections and tests to the validation agency.
      c. Submit Inspection and test reports specified in "Source Quality Control" Articles in Part 2 of this Section.
      d. Submit mill test reports on all materials used to fabricate system components.
      e. Isometric diagrams of “As-Built” condition including weld number, date and Welder I.D. number for each Field Weld.

1.5 QUALITY ASSURANCE

A. Comply with the latest versions of the following codes and provisions, including all addendum, errata, and revisions:
   1. ASME B31.3 for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
   2. Fabricate and stamp tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.6 CERTIFICATIONS

A. Only factory-trained and certified installers shall install thermoplastic piping. Installers of heat fusion thermoplastic joints shall hold current certifications in the installation and fusion methods from the respective pipe manufacturers.

1.7 DELIVERY STORAGE AND HANDLING

A. Packing/Shipping/Handling/Unloading
   1. Ship tube and pipe with capped ends. Insert stainless steel tubing in 6 mil poly protective plastic sleeves prior to packing.
   2. Bundle tube together and ship in tri-wall boxes in accordance with manufacturer’s established procedures.
   3. Ship fittings and valves with end caps and in individual plastic bags, properly sealed. Include part number, heat trace number(s), and the packing date with each valve and fitting.

B. Storage and Protection
   1. Store pipe, tube, fittings and valves on site in accordance with manufacturer recommendations.

2. Place materials indoors and on elevated platforms in a dry location away from construction activity that may cause damage or contamination.
3. Maintain packaging, caps and seals on all materials until ready for immediate installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements stated herein and with the Drawings, provide materials from one of the following manufacturers:
   1. Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings
      a. George Fischer
      b. Sani-Tech
      c. Enfield
   2. Polypropylene Pipe and Fittings
      a. George Fischer
      b. Sani-Tech
      c. Enfield
      d. Trent Tube
      e. G&H Products
      f. Alfa Laval
      g. Tri-Clover
   3. PVC and CPVC Valves, Actuators and Strainers
      a. George Fischer
      b. Asahi
      c. Sani-Tech
      d. Hayward Safe Block
      e. Plast-O-Matic
   4. Polypropylene Valves and Actuators
      a. George Fischer
      b. Asahi
      c. Sani-Tech
      d. Hayward Safe Block
      e. Plast-O-Matic

B. All pipe and components of a given pipe class shall originate from one source and be the product of a single manufacturer (e.g., All P10 ball valves, diaphragm valves and check valves shall be by one manufacturer).

C. When possible, all stainless steel fittings, valves and weldable parts of the same nominal diameter shall be purchased with the same heat trace number to standardize weld quality for each tubing size.

2.2 PIPE MATERIALS SPECIFICATION INDEX

A. The following table summarizes the pipe classes specified in this Section. Refer to the respective Pipe Class data sheets for detailed requirements.

Service	Drawing Tag	Maximum Service Operating Limits		Class	Pipe Material
		Pressure (psig)	Temperature (°F)		
PRE-TREATMENT WATER	NPCW	100	70	P10	PVC
ASTM/CAP REAGENT WATER	RO	100	68	P20	PIGMENTED POLYPROPYLENE

2.3 PRE-TREATMENT WATER PIPING

PIPE CLASS P10			
ITEM	SPECIFICATION		
Pipe	Material	Polyvinylchloride (PVC), Type 1 complying with ASTM D3915.	
	Manufacture	ASTM D1784.	
	Wall Thickness	Schedule 80.	
	Tensile Strength		
	Pressure Rating		
	Purity		
Fittings	Material	PVC complying with ASTM 2467.	
	End Connections	Socket for solvent weld. Flanged or threaded joints at equipment connections and where noted on P&ID's.	
Joints	Method	Solvent cementing methods per ASTM D2855 standard procedures.	
	Solvent	Use ASTM D2564 solvent.	
	Primer	Use ASTM F656 primers.	
Flange	ANSI B16.5 Class 150 pattern of same pipe material.		
Valves			
Ball	Materials	Body	PVC, Type 1, ASTM D1784
		Ball	PVC
		Seat	Polytetrafluoroethylene (PTFE)
		O-Ring	Viton
		Stem	Manufacturer Standard
	End Connections	Union or solvent cement socket.	

PIPE CLASS P10			
ITEM	SPECIFICATION		
	Pressure Rating	2" and smaller	230 psig at 68ºF.
		2.5" and larger	150 psig at 68ºF.
	Stem	Blow-out proof.	
	Model	Equal to George Fischer Type 560.	
Check	Materials	Body	PVC, Type 1, ASTM D1784.
		Ball	PVC
		Seat	Polytetrafluoroethylene (PTFE)
	End Connections	Union or solvent cement socket.	
	Pressure Rating	150 psig at 68ºF.	
	Model	Equal to George Fischer Type 360.	
Diaphragm	Materials	Body	PVC, Type 1, ASTM D1784.
		Diaphragm	Polytetrafluoroethylene (PTFE)
		Stem	Manufacturer Standard
		Bonnet	PVC
	End Connections	Flange	
	Pressure Rating	150 psig at 68ºF.	
	Position Indicator	Yes.	
	Model	Equal to George Fischer Type 317.	
Globe,	Materials	Body	PVC, Type 1, ASTM D1784.

PIPE CLASS P10			
ITEM	SPECIFICATION		
Y-Pattern		Diaphragm	Polytetrafluoroethylene (PTFE)
		Stem	Manufacturer Standard.
	End Connections	Union or solvent cement socket. Refer to P&ID's.	
	Pressure Rating	125 psig at 68ºF.	
	Actuator	Pneumatic piston with limit switches. FO or FC as noted on P&ID's.	
	Model	Equal to Aquamatic.	
Strainer	Model		
Use Point			

2.4 THERMOPLASTIC PURE WATER PIPING

PIPE CLASS P20			
ITEM	SPECIFICATION		
Pipe	Material	Polypropylene, Pigmented. Type II Copolymer.	
	Manufacture	ASTM D4101	
	Wall Thickness	SDR 11.	
	Tensile Strength	3900 psi at 73ºF. Conform to ASTM D-638.	
	Pressure Rating	150 psig at 68ºF. 50 psig at 200ºF. Conform to ASTM D-2837.	
	Purity	Adequate for contact with deionized water.	
Fittings	Material	Comply with pipe specifications.	
	End Connections	4" and smaller	Socket fusion. Flanged at equipment or where noted on the P&ID.

PIPE CLASS P20			
ITEM	SPECIFICATION		
		5” and larger	Butt fusion.
Joints	Method	Comply with ASTM D2657 procedures.	
	Equipment	Use fusion joining equipment supplied by pipe/fitting manufacturer.	
	Other	Fusion inserts and prefabricated coil fusion fittings are **prohibited.**	
Flange	ANSI B16.5 Class 150 pattern of same pipe material.		
Valves			
Ball	Materials	Body	Polypropylene, ASTM D4101.
		Ball	Polypropylene
		Seat	Polytetrafluoroethylene (PTFE)
		O-Ring	Viton
		Stem	Manufacturer Standard
	End Connections	Union or socket heat fusion.	
	Pressure Rating	2” and smaller	230 psig at 68ºF.
		2.5” and larger	150 psig at 68ºF.
	Stem	Blow-out proof.	
	Model	Equal to George Fischer Type 346.	
Check	Materials	Body	Polypropylene, ASTM D4101.
		Ball	Polypropylene
		Seat	EPDM
	End Connections	Union or socket heat fusion.	
	Pressure Rating	150 psig at 68ºF.	

PIPE CLASS P20			
ITEM	SPECIFICATION		
	Model	Equal to George Fischer Type 360.	
Diaphragm	Materials	Body	Polypropylene, ASTM D4101.
		Diaphragm	Polytetrafluoroethylene (PTFE)
		Stem	Manufacturer Standard
		Bonnet	Polypropylene
	End Connections	Flange	
	Pressure Rating	150 psig at 68ºF.	
	Position Indicator	Yes.	
	Model	Equal to George Fischer Type 317.	
Pressure Reducing	Materials	Body	Polypropylene, ASTM D4101.
		Diaphragm	Polytetrafluoroethylene (PTFE)
		Stem	Manufacturer Standard.
	End Connections	Union or spigot. Refer to P&ID's.	
	Pressure Rating	150 psig at 68ºF.	
	Manometer	Attached to valve body to display reduced pressure.	
	Model	To 1.5"	George Fischer Type V782.
		2" and Up	George Fischer Type V82.
Back Pressure Regulator	Model	Same material specifications and end connections as pressure reducing valves. Equal to George Fischer Type V86.	
Use Point		Refer to details.	

PART 3 - EXECUTION

3.1 INSTALLERS

A. The installation of process systems requires an unusually high quality of workmanship and strict quality control and documentation. The Contractor is fully responsible for quality control documentation related to the experience, certifications, training, and field and shop procedures utilized. Maintain a continuous record of field or shop-installed or fabricated elements of the system to the individual(s) performing the Work.

B. An installation specialist shall install all piping insulation.

3.2 INSTALLATION

A. General:
   1. Refer to Division 22 sections for general requirements for pipe installation and pipe supports.
   2. Refer to Division 22 sections for general requirements for application of pipe insulation.
   3. Installation, including support spacing, compensation for expansion and contraction, and joining shall be in compliance with manufacturer's recommendations.
   4. Support all thermoplastic piping with continuous support channel under all horizontal pipe runs. Support pipe and channel from the piping suspension system.

B. Solvent-Cemented, Thermoplastic Pipe and Fitting Joints:
   1. Handle cleaners, primers, and solvent cements according to ASTM F 402.
   2. Follow ASTM D2855 standard procedures for the joining of solvent-cemented joints.

C. Heat Fused Olefin and Fluoropolymer Thermoplastic Pipe and Fitting Joints:
   1. Follow ASTM D2757standard procedures for the joining of heat fusion joints.
   2. Use heat fusion equipment supplied by the pipe and fitting manufacturer. Follow manufacturer’s instructions.

3.3 FIELD QUALITY CONTROL

A. At the Owner’s option and direction, remove an installed thermoplastic fitting identified by the Owner for a spot check. Removed fitting shall be sent to pipe manufacturer for evaluation. If the joint is evaluated as satisfactory, the Owner will pay for the replacement of the fitting. If the pipe manufacturer evaluates the joint as unsatisfactory, replace the fitting with new materials at no cost to the Owner.

B. If an unsatisfactory fitting is identified, the Owner shall reserve the right to have additional fittings removed for evaluation until the level of quality of the installation is proven to the Owner’s satisfaction at no additional cost.

C. Hydrostatically test all pipe systems with deionized water at 100 psig for one hour. Document all results.

3.4 CLEANING OF THERMOPLASTICS

A. If a system is to be sterilized in place, leak check and pressure test the system with air or water, prior to sterilization.

B. Disconnect any UV lights and remove any sub-micron filter cartridges from their housings and install 5 micron filter cartridges.

C. Close valves on inlet and outlet and open bypass on any DI bottles to prevent the sterilizing solution from entering DI bottles and contacting the resin, while still allowing the solution to circulate.

D. Fill storage tank to a depth of approximately 3 ft. with DI water. Calculate the total volume of water in the storage tank AND the piping loop. Add sufficient hydrogen peroxide (H_2O_2) to the water in the storage tank to result in a solution strength of 10% H_2O_2).

E. When circulating the H_2O_2 solution, sample the water at each sink valve, as follows, to verify the presence of the H_2O_2 solution:
   1. Utilize a Nach Co., Inc. premanufacturing test kit Model no. HYP-1 (Cat. No. 2291-00) or approved equal. This kit shall be used to test H202 presence by a drop count titration) thiosulfide method.
   2. Adjust the pH of a quart of potassium permanganate ($KMNO_4$) and pH 6.5 with sulfuric acid (H_2SO_4). A quart should be adequate for testing most systems.
   3. Draw approximately one-half cup of water from each sink valve, individually, and add a small amount of the test solution ($KMNO_4$) to the sample.
   4. If H_2O_2 is present in the sample, it will turn clear or brown; if no H_2O_2 is present, it will remain purple.

F. When testing verifies the H_2O_2 solution is present at all test locations, turn off the distribution pump and open inlet and outlet valve as required to retain the solution in the loop for a minimum of 12 hours, while isolating the tank from the loop.

G. During the 12 hour retention period, the storage tank can be drained and cleaned. This is accomplished by first draining the tank to below the manhole. Enter the tank and using suitable spraying device and pressure, wash the tank walls and dome with the residual H_2O_2 in the tank. After spraying, drain the tank to a suitable drain and then thoroughly rinse the interior with DI water allowing it to go to drain also. Vacuum any residual DI water and then dry the tank, replace the manhole and close the tank drain. Fill the storage tank with DI water and revalve or install a bypass to allow the building loop return line to discharge to drain for the flushing and draining of the loop.
   1. While performing the following tank cleaning procedure, full body protective gear including breathing apparatus is required. Also, a life line must be attached to the person entering the tank and an additional person should be stationed outside within sight and sound, in case of an emergency.

H. After the 12 hour retention period, flush the H_2O_2 solution in the loop to drain, utilizing the distribution pump and the DI water in the storage tank. Flush until testing with $KMNO_4$ indicates no residual H_2O_2 in the loop.

END OF SECTION 226710

N:\N0912.00\DOC\SPEC\2012_03-16_BID\226710 - PURIFIED WATER PIPING.DOC

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Available Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser Industries, Inc.; DMD Div.
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      d. JCM Industries.
      e. Smith-Blair, Inc.
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
1. Available Manufacturers:
   a. Cascade Waterworks Mfg. Co.
   b. Fernco, Inc.
   c. Mission Rubber Company.
   d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.
   d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
1. Manufacturers:
   a. Calpico, Inc.
   b. Central Plastics Company.
   c. Pipeline Seal and Insulator, Inc.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.
   c. Perfection Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products, Inc.
      c. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Link Seal.
      b. Metraflex Co.
      c. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Plastic. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

E. Split-Plate, Stamped-Steel Type: With concealed or exposed-rivet hinge, spring clips, and chrome-plated finish.

F. One-Piece, Floor-Plate Type: Cast-iron floor plate.

G. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 230500

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230500 - COMMON WORK RESULTS FOR HVAC.DOC

SECTION 230513 – COMMON MOTORS REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed motors.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

1.4 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:
   1. Compatible with the following:
      a. Magnetic controllers.
   2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
   3. Matched to torque and horsepower requirements of the load.
   4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed motors except as follows:
   1. Different ratings, performance, or characteristics for motor are specified in another Section.
   2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase.

B. Motors Smaller Than 1/2 HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open dripproof.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium, as defined in NEMA MG 1.

C. Stator: Copper windings, unless otherwise indicated.

D. Rotor: Squirrel cage, unless otherwise indicated.

E. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating, unless otherwise indicated.

G. Insulation: Class F, unless otherwise indicated.

H. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
   1. Finish: Gray enamel.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Designed with critical vibration frequencies outside operating range of controller output.
   2. Temperature Rise: Matched to rating for Class B insulation.
   3. Insulation: Class H.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

B. Rugged-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with non-hygroscopic material.
   1. Finish: Chemical-resistant paint over corrosion-resistant primer.

C. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:
   1. Measure winding resistance.
   2. Read no-load current and speed at rated voltage and frequency.
   3. Measure locked rotor current at rated frequency.
   4. Perform high-potential test.

2.5 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split-phase start, capacitor run.
   3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

E. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:
   1. Measure winding resistance.
   2. Read no-load current and speed at rated voltage and frequency.
   3. Measure locked rotor current at rated frequency.
   4. Perform high-potential test.

PART 3 - EXECUTION

Not Used.

END OF SECTION 230513

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.DOC

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Metal-bellows packless expansion joints.
   2. Pipe loops and swing connections.
   3. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
   2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   3. Alignment Guide Details: Detail field assembly and attachment to building structure.
   4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.

D. Product Certificates: For each type of expansion joint, from manufacturer.

E. Maintenance Data: For expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Metal-Bellows Packless Expansion Joints:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Expansion Joint Systems, Inc.
      b. Flex-Hose Co., Inc.
      c. Flexicraft Industries.
      d. Flex-Weld, Inc.
      e. Hyspan Precision Products, Inc.
      f. Metraflex, Inc.
      g. Universal Metal Hose; a subsidiary of Hyspan Precision Products, Inc.
   2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
   3. Type: Circular, corrugated bellows with external tie rods.
   4. Minimum Pressure Rating: 175 psig unless otherwise indicated.
   5. Configuration: Single joint with base and double joint with base classes unless otherwise indicated.
   6. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
      a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
      b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: threaded.
   7. Expansion Joints for Steel Piping: Single- or multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
      a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
      b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advanced Thermal Systems, Inc.
      b. Flex-Hose Co., Inc.
      c. Flexicraft Industries.
      d. Flex-Weld, Inc.
      e. Hyspan Precision Products, Inc.
      f. Metraflex, Inc.
      g. U.S. Bellows, Inc.
   2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:
   1. Steel Shapes and Plates: ASTM A 36/A 36M.
   2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
   3. Washers: ASTM F 844, steel, plain, flat washers.
   4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
      a. Stud: Threaded, zinc-coated carbon steel.
      b. Expansion Plug: Zinc-coated steel.
      c. Washer and Nut: Zinc-coated steel.
   5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
      a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
      b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
      c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:
   1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING.DOC

SECTION 230519 – METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following meters and gages for mechanical systems:

S**Solar** Thermometers.
2. Pressure Gages.
3. Thermowells.
4. Test plugs.
5. Turbine Flow Meters.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers gages and flowmeters indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SOLAR THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
   1. Trerice, H. O. Co.- Model SX9

B. Case: Die-cast aluminum, blue epoxy finish.

C. Stem: Aluminum.

D. Sensor: Glass passivated thermistor.

E. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

F. Display: 7/16-inch LCD Digits, 1/10 degree resolution, 10 LUX rating, 10 seconds update interval.

G. Accuracy: Plus or minus 1 percent reading or plus or minus 1 degree whichever is greater.

H. Range: 40° to 300°F.

2.3 THERMOWELLS

A. Manufacturers:
   1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
   2. Palmer - Wahl Instruments Inc.
   3. Trerice, H. O. Co.
   4. Weiss Instruments, Inc.
   5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES

A. Available Manufacturers:
   1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
   2. Palmer - Wahl Instruments Inc.
   3. Trerice, H. O. Co.
   4. Weiss Instruments, Inc.
   5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
   1. Case: Dry or Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   6. Pointer: Red or other dark-color metal.
   7. Window: Shatter proof glass.

8. Ring: Stainless steel.
9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:
1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 TEST PLUGS

A. Available Manufacturers:
1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
3. Carrying case shall have formed instrument padding.

2.6 TURBINE FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Badger Meter, Inc.; Industrial Div.
2. Data Industrial Corp.
3. Hoffer Flow Controls, Inc.
4. ONICON Incorporated.

B. Description: Insertion type for inserting turbine into piping and measuring flow directly in gallons per minute.

C. Construction: Stainless-steel body; with plastic turbine or impeller and integral direct-reading scale.

D. Pressure Rating: 150 psig minimum.

E. Temperature Rating: 180 deg F minimum.

F. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.

G. Accuracy: Plus or minus 2-1/2 percent.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install thermometers in the following locations:
1. Inlet and outlet of each hydronic boiler and chiller.
2. Inlet and outlet of each hydronic coil in air-handling unit.
3. Inlet and outlet of each thermal storage tank.
4. Inlet and outlet of each heat exchanger.
5. Inlet and outlet of each cooling tower.
6. Supply ducts.
7. Where shown on plans.

B. Install thermometers at suction and discharge of each pump.

C. Provide the following temperature ranges for thermometers:
1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
4. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
5. Glycol Water: 0 to 75 deg F, with 2-degree scale divisions.
6. Condenser Water: 30 to 140 deg F, with 2-degree scale divisions.
7. Supply Ductwork: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at chilled- water inlets and outlets of each chiller and boiler.

C. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending one-third of diameter of pipe to center of pipe and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

D. Install needle-valve and snubber fitting in piping for each pressure gage for fluids.

E. Install test plugs in tees in piping.

F. Install flow indicators, in accessible positions for easy viewing, in piping systems.

G. Install permanent indicators on walls or brackets in accessible and readable positions.

H. Install connection fittings for attachment to portable indicators in accessible locations.

I. Mount meters on wall if accessible; if not, provide brackets to support meters.

J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

K. Install flowmeter elements in accessible positions in piping systems.

L. Install connection fittings for attachment to portable indicators in accessible locations.

M. Install flowmeters as indicated on the drawings.

3.4 CONNECTIONS

A. Install gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

D. Connect flowmeter-system elements to meters.

E. Connect flowmeter transmitters to meters.

3.5 ADJUSTING

A. Adjust faces of gages to proper angle for best visibility.

B. Calibrate meters according to manufacturer's written instructions, after installation.

C. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 230519

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230519 - METERS AND GAUGES FOR HVAC PIPING.DOC

SECTION 230523 – GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Bronze ball valves.
2. Iron, single-flange butterfly valves.
3. Bronze lift check valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Chainwheels.

B. Related Sections:
1. Division 26 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 26 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set ball valves open to minimize exposure of functional surfaces.
   4. Set butterfly valves closed or slightly open.
   5. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 3 and smaller except plug valves.
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   2. Butterfly Valves: With extended neck.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   3. Solder Joint: With sockets according to ASME B16.18.
   4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.
      b. Milwaukee Valve Company.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Three piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Bronze.
      i. Ball: Chrome-plated brass or stainless steel.
      j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. DeZurik Water Controls.
      e. Milwaukee Valve Company.
      f. Mueller Steam Specialty; a division of SPX Corporation.
      g. NIBCO INC.
      h. Spence Strainers International; a division of CIRCOR International.
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating: 150 psig.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      e. Seat: EPDM.
      f. Stem: One- or two-piece stainless steel.
      g. Disc: Stainless steel.

2.4 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
   2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

B. Class 250, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

C. Class 250, Iron, Globe, Center-Guided Check Valve with Metal Seat:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. DeZurik
b. Metraflex, Inc.
c. Milwaukee Valve Company.
d. Mueller Stream Specialty; a division of SPX Corporation.
2. Description:
a. Standard: MSS SP-125
b. NPS 2-1/2 to NPS 5, CWP Rating: 400 psig.
c. Body Material: ASTM A 126, gray iron.
d. Style: Globe, spring loaded.
e. Ends: Flanged.
f. Seat: Bronzed.

2.7 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly and plug valve stems.
3. Sprocket Rim with Chain Guides: Aluminum or Bronze, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

F. Examine piping system for compliance with requirements for installation and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly and plug valves NPS 4 and larger and 96 inches or higher above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, or plug valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: See Section 232113- Hydronic Piping.
4. Pump-Discharge Check Valves:
    a. NPS 2 and Smaller: Bronze swing check valves with bronze disc (horizontal) or bronze lift check valves (vertical).
    b. NPS 2-1/2 and Larger: Iron swing check valves with metal-seat (horizontal) or iron globe, center guided (vertical).

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

CHILLED, GLYCOL AND CONDENSSER WATER SERVICE Maximum 150°F and 150 psig (3/4"-5")						
Specialty	Application	Type	Size	Body/Seat Body/Trim	Connection	Minimum Rating, [1,2]
Ball Valve	Isolation (with locking handle)	Full Port 3-pc.	3/4"-2"	Bronze/Teflon	Sweat[1]	400 psig WOG
	Drain and Manual vent	Full Port 2 pc.	3/4"-10"	Bronze/Teflon	Threaded	400 psig WOG
Butterfly Valve	Isolation	Class 150	2 1/2"-12"	Iron/EPDM	Flanged/ Lug	CWP 150 psig bidirectional Shutoff 150 psig dead-end service
Check Valve	Pumps	Vertical, Globe/Center Guided	2 1/2"-10"	Gray Iron	Flanged	Class 250
		Horizontal Swing				

1. These are minimum ratings for ASTM A 126, Class B and ASTM B-61 and 62. For higher pressures and temperatures, adjust values to in- Include static head plus 1.1 times pressure relief valve settings plus pump shutoff head pressure. For actual maximum allowable valve and strainer ratings, refer to "Pressure-Temperature Ratings - Non Shock" tables and Adjusted Pressure Ratings" for copper tube, soldered end valves [and strainers]
2. SWP=Steam Working Pressure CWP=Cold Water Working Pressure WSP=Working Steam Pressure WOG=Water, Oil or Gas Class=ANSI Standard

Use 1/8" dia for plate heat exchanger application.

HOT WATER SERVICE Maximum 200°F and 150 psig (3/4"-4")						
Specialty	Application	Type	Size	Body/Seat Body/Trim	Connection	Minimum Rating, [1,2]
Ball Valve	Isolation (with locking handle)	Full Port 3-pc.	3/4"-2"	Bronze/Teflon	Sweat[1]	400 psig WOG
	Drain and Manual vent	Full Port 2 pc.	3/4"-8"	Bronze/Teflon	Threaded	400 psig WOG
Butterfly Valve	Isolation	Class 150	2 1/2"-12"	Iron/EPDM	Flanged/ Lug	CWP 150 psig bidirectional Shutoff 150 psig dead-end service
Check Valve	Pumps	Vertical, Globe/Center Guided	2 1/2"-8"	Gray Iron	Flanged	Class 250
		Horizontal Swing	2 1/2"-8"	Gray Iron	Flanged	Class 250
		Vertical, Lift	3/4"-2”	Bronze	Threaded	Class 125
		Horizontal Swing	3/4"-2"	Bronze	Threaded	Class 125

1. These are minimum ratings. For higher pressures and temperatures, adjust these values to include static head plus 1.1 times pressure relief valve Settings plus pump shutoff head pressure. For actual maximum allowable valve and strainer ratings, refer to" Pressure-Temperature Ratings - Non Shock" tables.
2. SWP=Steam Working Pressure CWP=Cold Water Working Pressure WOG=Water, Oil or Gas Class = ANSI Standard.
3. Use 1/8" for dia for plate heat exchanger application

3.5 JOINT CONSTRUCTION

A. Refer to Division 23 Section “Hydronic Piping” for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer’s written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.6 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for mechanical system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Pipe positioning systems.
   8. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Powder-actuated fastener systems.
   4. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.

2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code—Steel.

B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Carpenter & Paterson, Inc.
3. Grinnell Corp.
4. Piping Technology & Products, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Power-Strut Div.; Tyco International, Ltd.
3. Thomas & Betts Corporation.
4. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
1. Carpenter & Paterson, Inc.
2. Pipe Shields, Inc.
3. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
a. Hilti, Inc.
b. ITW Ramset/Red Head.
c. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
a. B-Line Systems, Inc.; a division of Cooper Industries.

b. Hilti, Inc.
c. ITW Ramset/Red Head.
d. Powers Fasteners.

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:
1. C & S Mfg. Corp.
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
   3. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
   4. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
   5. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
   6. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   4. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
   5. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
   6. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
   7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb.
      b. Medium (MSS Type 32): 1500 lb.
      c. Heavy (MSS Type 33): 3000 lb.
   8. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

9. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
   6. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
   7. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 15 Section "Plumbing Fixtures" for plumbing fixtures.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

N. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT.DOC

SECTION 230533 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes heat tracing with the following electric heating cables:
   1. Self-regulating, parallel resistance.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
   1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: 15 Insert number years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Raychem; a division of Tyco Thermal Controls or a comparable product by one of the following:
   1. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
   2. Pyrotenax; a division of Tyco Thermal Controls.

B. Heating Element: Pair of parallel No. 16 AWG, nickel-coated stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

C. Installation: Wrap single strip heating elements throughout entire length of piping.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid, and polyolefin outer jacket with UV inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Maximum Operating Temperature: 300 deg F.

I. Capacities and Characteristics:
   1. Maximum Heat Output: 8 W/ft..
   2. Piping Diameter: 5 NPS.
   3. Number of Parallel Cables: 2
   4. Volts: 120 V.
   5. Phase: 1
   6. Hertz: 60

2.2 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 15 Section "Mechanical Identification."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
   1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cables after piping has been tested and before insulation is installed.

B. Install electric heating cables according to IEEE 515.1.

C. Install insulation over piping with electric cables according to Division 23 Section "Pipe Insulation."

D. Install warning tape on piping insulation where piping is equipped with electric heating cables.

E. Set field-adjustable switches and circuit-breaker trip ranges.

F. Protect installed heating cables, including nonheating leads, from damage.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

1. Test cables for electrical continuity and insulation integrity before energizing.
2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 230533

SECTION 230548 – VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 23 apply to work in this Section

1.2 SUMMARY

A. Extent of vibration control work required by this section is indicated on drawings and/or specified in this and other Division 23 sections.

B. Types of vibration control products specified in this section include the following:
1. Neoprene Pads.
2. Vibration Isolation Springs.
3. All-Directions Anchors.
4. Neoprene Mountings.
5. Spring Isolators, Free-Standing.
6. Spring Isolators, Vertically-Restrained.
7. Flexible Pipe Connectors.
8. Spring supported concrete inertia bases.

C. Vibration control product furnished as integral parts of factory-fabricated equipment, are specified herein and as part of equipment assembly in other Division 15 sections.

D. Refer to other Division 23 sections for equipment foundations, hangers, sealants, gaskets, and other work related to vibration control work.

E. Refer to other Division 23 sections for requirements of electrical connections to equipment isolated on vibrations control products.

F. Refer to other Division 23 sections for requirements of duct connections to air handling equipment isolated on vibration control products.

G. Refer to other Division 23 sections for requirements of piping connections to equipment isolated on vibration control products.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
1. Except as otherwise indicated, obtain vibration control products from single manufacturer.
2. Engage manufacturer to provide technical supervision of installation of vibration control products.

B. All vibration isolators shall have calibration markings or some method to determine adjustment and the actual deflection under the imposed load after installation and adjustment.

C. All isolators shall operate within the linear position of their load vs. deflection curves. Load vs. deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of not less than 50% above the design deflection.

D. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than +10%.

E. These specifications describe spring hangers with 30 degree misalignment feature. This requirement is mandatory. The contractor shall replace any hangers without a 30 degree capability discovered on site at no additional cost to the Owner.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of vibration control product. Submit schedule showing size, type, deflection and location for each product furnished.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components. Detail bases, and show location of equipment anchoring points, coordinated with equipment manufacturers' shop drawings.

C. Maintenance Data: Submit maintenance data for each type of vibration control product. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products manufactured by Mason Industries, Amber/ Booth Co., Vibration Mountings and Controls or Kinetics Noise Control meeting or surpassing the specifications shall be acceptable.

2.2 VIBRATION CONTROL MATERIALS AND SUPPORTS UNITS

A. Neoprene Pads (Type A): Oil-resistant neoprene sheets, of manufacturer's standard hardness, and cross-ribbed or waffled pattern. Pads shall be minimum 1/4 inch thick and shall be comprised of multiple layers to achieve specified deflection. Provide 1/16 inch thick steel shims between multiple layers. Provide top bearing plate as necessary to uniformly load pads. Minimum 1/8 inch deflection.

B. Vibration Isolation Springs (Type B): Wound-steel compression springs, or high-strength spring alloy steel; with spring diameter not less than 0.8 of compressed height of spring at rated loads. Provide minimum additional travel to solid, equal to 50% of rated deflection. Provide spring wire with elastic limit stress exceeding at solid deflection.

C. All-Directional Anchors (Type D): Provide all-directional acoustical pipe anchor consisting of telescopic arrangement of 2 sizes of steel tubing separated by minimum 0.5 inch thickness of

heavy-duty neoprene and duck, or neoprene isolation material. Provide vertical restraints by similar material arranged to prevent vertical travel in either direction. Design for maximum 500 psig load on isolation materials, and provide for equal resistance in any direction. Equip all anchors with threaded hole on top and 2 holes in base plate for bolting down; or provide welding provisions top and bottom, where indicated.

D. Neoprene Mountings (Type E): Provide neoprene mountings consisting of a neoprene-in-shear element bonded between 2 steel plates that are neoprene-covered to prevent corrosion. Provide minimum rated deflection of 3/8 inch. Provide threaded hole in upper plate and 2 holes in base plate for securing to equipment and substrate. Type E-H shall be hanger with a Type E isolation element.

E. Spring Isolators, Free-Standing (Type F): Except as otherwise indicated, provide vibration isolation spring (Type B) between top and bottom loading plates, and with pad-type isolator (Type A) bonded to bottom of bottom loading plate. Include studs or cups to ensure centering of spring on plates. Include leveling bolt with lock nuts and washers, centered in top plate, arranged for leveling and anchoring supported equipment as required. Provide holes in bottom plate for bolting unit to substrate as required. Provide resilient bushings and washers when bolting isolator to substrate.

F. Spring Isolators, Vertically-Restrained (Type G): Provide spring isolators (Type B) in housing that includes vertical limit stops. Design housing to act as blocking during erection, and with installed height and operating height being equal. Maintain 0.5 inch minimum clearance around restraining bolts, and between housing and springs. Design so limit stops are out of contact during normal operation.

G. Isolation Hangers (Type L): Hanger units formed with brackets and including manufacturer's standard compression isolators of type indicated. Design brackets for 3 times rated loading of units. Fabricate units to accept misalignment of 30 degrees off center in any direction before contacting hanger box, and for use with either rod or strap type members, and including acoustical washers to prevent metal-to-metal contacts.
   1. Provide vibrations isolation spring (Type B) with cap in lower part of hanger and rubber hanger element in top, securely retained in unit.
   2. Provide neoprene element, with minimum deflection of 3/8 inch, securely retained in hanger box.
   3. Provide hangers, precompressed to rated load to limit deflection during installation. Design so hanger may be released after full load is applied.

H. Spring supported concrete inertia base (Type O):
   1. Concrete inertia bases shall be formed, finished and reinforced to prevent flexure, misalignment of drive and driven unit or stress transfer to equipment.
   2. Minimum thickness of inertia base shall be as follows, with base weight not less than 1.5 times equipment weight as recommended by manufacturer:

MOTOR SIZE HP	MIN. THICKNESS (inches)
5 – 15	6
15 – 50	8

   3. A minimum 1 ½ -2 inches space shall be maintained between the inertia base and building structure.
   4. Inertia bases shall be supported by Type F isolators with minimum 2 inches deflection.

I. Flexible Pipe Connectors:
   1. For non-ferrous piping, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.
      a. Provide for pump suction and discharge piping 2 inches and less.
   2. For ferrous piping, provide stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psig ANSI flanges, welded to hose.
      a. Provide for pump suction and discharge piping 2½ to 4 inches.
   3. Double spherical neoprene flexible connector (Type N):
      a. Manufactured of nylon tire cord and neoprene both molded and cured with hydraulic presses.
      b. Rated 150 psig at 200 deg. F.
      c. Size 12 inches or larger and systems above 150 psig class shall have control cables or rods with end fittings isolated from anchor plates by means of 0.5 inch thick bridge bearing neoprene washer bushings.
      d. Provide for pump suction and discharge piping larger than 4-inches.

PART 3 - PART – 3 EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PERFORMANCE OF ISOLATORS

A. General: Comply with minimum static deflections as tabulated in this section, but not less than recommended by latest edition of ASHRAE, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.3 APPLICATIONS

A. General: Except as otherwise indicated, select vibration control products in accordance with latest edition of ASHRAE Applications Handbook, "Sound and Vibration Control" chapter. Where more than one type of product is offered, selection shall be the most efficient isolator.

B. Piping: For piping connected to equipment mounted on vibration control products, install isolation hangers as indicated, and for first 3 points of support for pipe sizes 4 inches and less and for first 4 points of support for pipe sizes 5 inches through 10 inches. All piping in mechanical rooms shall be mounted on Type G isolators with 2 inches deflection or suspended by Type L hangers with 2 1/4 inch deflection. Piping within 75 feet from equipment connections shall be mounted on Type G isolators with (2 inch) deflection or suspended by Type L hangers with 2 1/4 inch deflection.

3.4 INSTALLATION

A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or

bearing points. Remove space blocks and similar devices intended for temporary support during installation.

B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

D. Install inertia base frames on isolator units as indicated, so that minimum of 1½- 2 inch clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation. A minimum 1½- 2 inch clearance shall be maintained between all isolated bases and building structure.

E. Locate isolation hangers as near to overhead support structure as possible. All hanging points shall be from main structural elements.

F. Weld riser isolator units in place as required to prevent displacement from loading and operations.

G. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.5 ADJUSTING AND CLEANING

A. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

B. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.6 VIBRATION ISOLATION SCHEDULE

A. Provide the most efficient and effective isolation system and deflection where a conflict may exist between the following schedule, individual equipment specifications or ASHRAE recommendations. Provide ASHRAE recommended isolators for 35 feet structural spans whether or not a 35 feet span exists.

Table A				Equipment Installation Attachment Point								
				On Grade			Above Grade			Roof		
EQUIPMENT		SIZE (3)(4)	MOUNTING	ISOL	MIN DEFL (1)	BASE	ISOL	MIN DEFL (1)	BASE	ISOL	MIN DEFL (1)	BASE
Vibration Isolation - Requirements for HVAC Equipment												
BOILERS		ALL	FLOOR	A	0.25	--	--	--	--	--	--	--
AIR HANDLING UNITS		ALL	FLOOR	A	0.5	--	A	0.5				
COOLING TOWER		ALL (5)	--	--	--	--	--	--	--	G	1.0	A
CENTRIFUGAL INLINE FANS		ALL	CEILING	--	--	--	L	1.5	--	--	--	--
UTILITY SET FAN		ALL	FLOOR				F	2.0	O			
PROPELLER FANS		ALL	WALL	--	--	--	L	0.5	--	--	--	--
CHILLER		ALL	FLOOR	G	1.0	--	--	--	--	--	--	--
SPLIT SYSTEM INDOOR EVAPORATORS		ALL	CEILING	--	--	--	E	0.5	--	--	--	--
UNIT HEATERS		ALL	CEILING	--	--	--	B	0.5	--	--	--	--
PUMPS	BASE MOUNTED	ALL	FLOOR	A	0.50		A	0.50	--	-- A	0.50	--
	INLINE	ALL	PIPE MOUNTED	--	--	--	L	0.75	--	--	--	--
CONDESNSING UNITS		ALL	ROOF	--	--	--	--	--	--	A	0.5	
Vibration Isolation – Requirements for Plumbing and Control Equipment												
AIR COMPRESSORS AND VACUUM PUMPS	TANK	TO 10 HP	FLOOR	D	0.30	--	B	0.75	--			
		OVER 10 HP		B	0.75	---	B	1.50	B-1			
	UNITARY	TO 10 HP		D	0.30	--	B	0.75	B-2(2)			
		OVER 10 HP		B	0.75	--	B	1.50	B-2(2)			
PUMPS	BASE MOUNTED	TO 15 HP	FLOOR	D	0.30	--	B	0.75	B-1			
		OVER 15 HP	FLOOR	B	0.75	--	B	0.75	B-1			

Table A				Equipment Installation Attachment Point								
				On Grade			Above Grade			Roof		
EQUIPMENT		SIZE (3)(4)	MOUNTING	ISOL	MIN DEFL (1)	BASE	ISOL	MIN DEFL (1)	BASE	ISOL	MIN DEFL (1)	BASE
	INLINE	ALL	FLOOR	--	--	--	D	0.30	--			
				--	--	--	F	0.75	--			

1) Static deflection shall be determined based on the deflection guide. Deflections indicated are minimums at actual load and shall be selected from manufacturer's nominal 4", 3", 2" and 1" deflection spring series. R.P.M. is defined as the slowest operating speed of the equipment.

2) Single stroke compressor may require inertia bases with thickness greater than 14" max. As described for Base B-2. Inertia as mass shall be sufficient to maintain double amplitude of 1/8".

Deflection Guide	
RPM	Deflection
Less than 300	3.50"
301 to 500	2.50"
Over 500	1.50"

3) Equipment with less than one H.P. are excluded from vibration requirements.

4) For equipment with multiple motors, H.P. classification applies to largest single motor.

5) Epoxy coated spring and housing assembly with stainless steel bolts and nuts for outdoor installation.

END SECTION 230548

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Access panel and door markers.
5. Pipe markers.
6. Duct markers.
7. Valve tags.
8. Valve schedules.
9. Warning tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
   1. Terminology: Match schedules as closely as possible.
   2. Data:
      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
   3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   1. Data: Instructions for operation of equipment and for safety procedures.
   2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
   3. Thickness: 1/8 inch, unless otherwise indicated.
   4. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
   5. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
   1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
   1. Colors: Comply with ASME A13.1, unless otherwise indicated.
   2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
   4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.

5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.
1. Material: 0.032-inch- thick brass or aluminum.
2. Material: 0.0375-inch- thick stainless steel.
3. Material: 3/32-inch- thick laminated plastic with 2 black surfaces and white inner layer.
4. Valve-Tag Fasteners: Brass wire-link or beaded chain.

2.5 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.

2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Fuel-burning units, including boilers, and heaters.
   2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   3. Coils, evaporators, and similar equipment.
   4. Fans, blowers and primary balancing dampers.
   5. HVAC central-station air handling units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
   1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
      b. Fire department hose valves and hose stations.
      c. Meters, gages, thermometers, and similar units.
      d. Fuel-burning units, including boilers, and heaters.
      e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
      f. Coils, evaporators, and similar equipment.
      g. Fans, blowers and primary balancing dampers.
      h. HVAC central-station air handling units.
      i. Tanks and pressure vessels.
      j. Strainers, filters, water-treatment systems, and similar equipment.
      k. Exhausted and ventilation fans.
      l. Cooling towers.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with equipment markers in the following color codes:
   a. Green: For cooling equipment and components.
   b. Yellow: For heating equipment and components.
   c. Orange: For combination cooling and heating equipment and components.
2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
4. Include signs for the following general categories of equipment:
   a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
   b. Fuel-burning units, including boilers, and heaters.
   c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   d. Coils, evaporators, and similar equipment.
   e. Fans, blowers, primary balancing dampers, and mixing boxes.
   f. HVAC central-station air handling units.
   g. Tanks and pressure vessels.
   h. Strainers, filters, water-treatment systems, and similar equipment.
   i. Exhaust fans and ventilation fans.
   j. Cooling towers.

D. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:
   1. Green: For cold-air supply ducts.
   2. Yellow: For hot-air supply ducts.
   3. Blue: For exhaust-, outside-, relief-, and return-ducts.
   4. Purple: For laboratory exhaust systems.
   5. ASME A13.1 Colors and Designs: For hazardous material exhaust.
   6. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
   1. Valve-Tag Size and Shape:
      a. Cold Water: 2 inches, round.
      b. Hot Water: 2 inches, round.
      c. Fire Protection: 2 inches, round.
      d. Gas: 2 inches, round.
   2. Valve-Tag Color:
      a. Cold Water: Green.
      b. Hot Water: Yellow.
      c. Fire Protection: Red.
      d. Gas: Blue.
   3. Letter Color:
      a. Cold Water: White.
      b. Hot Water: Black.
      c. Fire Protection: White.
      d. Gas: White.

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 230553

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT.DOC

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Variable-flow hydronic systems.
      b. Primary-tertiary- hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. LEED Submittal:
   1. Air-Balance Report for LEED Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

E. Certified TAB reports.

F. Sample report forms.

G. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Meet with Architect, Owner, Construction Manager and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide fourteen (14) days' advance notice of scheduled meeting time and location.
   1. Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Coordination and cooperation of trades and subcontractors.
      d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect Construction Manager and Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide fourteen (14) days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for return to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or

in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, air valves, indoor fan coils, unit heaters and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine two and three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, variable frequency drives, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
2. Measure fan static pressures as follows to determine actual static pressure:
    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    a. Report the cleanliness status of filters and the time static pressures are measured.
4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
    a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
   2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   3. Measure total system airflow. Adjust to within indicated airflow.
   4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
   5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
   6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
      a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
   7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
   8. Record final fan-performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check liquid level in expansion tank.
   3. Check makeup water-station pressure gage for adequate pressure for highest vent.
   4. Check flow-control valves for specified sequence of operation, and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Division 23 Section "Hydronic Pumps."
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
      a. Monitor motor performance during procedures and do not operate motors in overload conditions.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-TERTIARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the tertiary circuits.

3.11 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure.

E. Check settings and operation of safety and relief valves. Record settings.

3.12 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.13 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. Obtain additional balancing requirements for ammonia chillers from manufacturer.

3.14 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:
   1. Measure condenser-water flow to each cell of the cooling tower.
   2. Measure entering- and leaving-water temperatures.
   3. Measure wet- and dry-bulb temperatures of entering air.
   4. Measure wet- and dry-bulb temperatures of leaving air.
   5. Measure condenser-water flow rate recirculating through the cooling tower.
   6. Measure cooling-tower spray pump discharge pressure.
   7. Adjust water level and feed rate of makeup water system.
   8. Measure flow through bypass.

3.15 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.16 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

3.17 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.18 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.19 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.20 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.

5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Outdoor-air damper position.
   l. Return-air damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft..
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
   n. Refrigerant suction temperature in deg F.
   o. Inlet steam pressure in psig.

G. Gas- Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Fuel type in input data.

g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):
a. Total air flow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
a. Unit identification.
b. Location.
c. Service.

d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

M. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.21 INSPECTIONS

A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 10 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect, Owner, Construction Manager and Commissioning Authority.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect, Owner, Construction Manager and Commissioning Authority.
3. Architect, Owner, Construction Manager and Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.22 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC.DOC

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Flexible elastomeric.
      b. Mineral fiber.
      c. Cellular Foam
   2. Adhesives.
   3. Mastics.
   4. Lagging adhesives.
   5. Sealants.
   6. Field-applied fabric-reinforcing mesh.
   7. Field-applied cloths.
   8. Field-applied jackets.
   9. Tapes.
   10. Securements.
   11. Corner angles.

B. Related Sections:
   1. Division 22 Section "Fire-Suppression Systems Insulation."
   2. Division 21 Section "Plumbing Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at pipe expansion joints for each type of insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties, equipment connections, and access panels.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

E. Mineral-Fiber, Preformed Pipe Insulation with factory applied all service jacket (ASJ):
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Micro-Lok.
      b. Knauf Insulation; 1000 Pipe Insulation.
      c. Owens Corning; Fiberglas Pipe Insulation.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Microlite.
      b. Knauf Insulation; Duct Wrap.
      c. Owens Corning; All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; 800 Series Spin-Glas.
      b. Knauf Insulation; Insulation Board.
      c. Owens Corning; Fiberglas 700 Series.

H. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; 1000 Series Spin-Glas.
      b. Owens Corning; High Temperature Industrial Board Insulations.
      c. Knauf-Elevated Temperature (ET) Board

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; MicroFlex.
      b. Knauf Insulation; Pipe and Tank Insulation.
      c. Owens Corning; Fiberglas Pipe and Tank Insulation.

J. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Pittsburgh Corning Corporation; Foamglas.

2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Insulco, Division of MFS, Inc.; Triple I.
   b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Insulco, Division of MFS, Inc.; SmoothKote.
   b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
   c. Rock Wool Manufacturing Company; Delta One Shot.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA Inc.; Aeroseal.
   b. Armacell LCC; 520 Adhesive.
   c. Foster Products Corporation, H. B. Fuller Company; 85-75.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-82.
   b. Foster Products Corporation, H. B. Fuller Company; 85-20.

D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-82.
   b. Foster Products Corporation, H. B. Fuller Company; 85-20.

E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); 739, Dow Silicone.
   b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Speedline Vinyl Adhesive.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-30.
   b. Foster Products Corporation, H. B. Fuller Company; 30-35.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Encacel.
   b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide the following:
   a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.

b. Vimasco Corporation; Elastafab 894.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper.
   d. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.

c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
a. Products: Subject to compliance with requirements, provide one of the following:
1) AGM Industries, Inc.; CWP-1.

2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO.
      2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, galvanized steel.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. C & F Wire.
      b. Childers Products.
      c. PABCO Metals Corporation.
      d. RPR Products, Inc.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for

fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Pipe: Install insulation continuously through floor penetrations.
   3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
      d. Do not overcompress insulation during installation.
      e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      f. Impale insulation over anchor pins and attach speed washers.
      g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
   6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
   7. Stagger joints between insulation layers at least 3 inches.
   8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
   9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
   10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. Construct pump body insulation with removeable aluminum sheet metal covers and pre-formed cellular insulation.
5. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
6. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face

and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform inspections.

B. All insulation applications will be considered defective work, if sample inspection reveals noncompliance with requirements.

3.12 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in nonconditioned space.
   4. Indoor, exposed return located in nonconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.

6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:
1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.

3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, rectangular, round and flat-oval, supply and return air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density. Thermal Conductivity (K value): Not greater than 0.27 at mean temperature of 75 degF, when installed. Operating service temperature 40 degF to 250 degF.

B. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be one of the following:
1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF maximum service temperature 450 degF.

C. Exposed, rectangular, supply, return, outside air duct and plenum insulation shall be one of the following:
1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF maximum service temperature 450 degF.

D. Exposed, round and flat-oval, supply and return air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density. Thermal Conductivity (K value): Not greater than 0.27 at mean temperature of 75 degF, when installed. Operating service temperature 40 degF to 250 degF.

E. Exposed, rectangular, outdoor-air duct and plenum insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF maximum service temperature 450 degF.

F. Exposed, rectangular, exhaust and relief air duct from exhaust plenum at louver (or other outside opening) back to exhaust air damper (motorized or gravity) plus 36-inches insulation shall be one of the following:
1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF maximum service temperature 450 degF.

3.14 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Heating-hot-water expansion/compression tank insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF maximum service temperature 450 degF. Insulate flanges and fittings with mineral fiber cement. Reinforce end and irregular surfaces with Glass Fab embedded in two coats of Foster 30-36 adhesive.

D. Heating-hot-water air-separator insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF maximum service temperature 450 degF. Insulate flanges and fittings with mineral fiber cement. Reinforce end and irregular surfaces with Glass Fab embedded in two coats of Foster 30-36 adhesive.

3.15 PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF.

B. Chilled Water, 40 to 56 Deg F:
1. Cellular foam, preformed pipe, Type II, Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF. Insulation shall be the following:
a. 1-1/2 inches and Smaller: 1 inch thick.
b. 2inches and Larger: 1-1/2- inches thick.

C. Glycol Water, 22 to 52 Deg F:
1. Cellular foam, preformed pipe, Type II, Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF. Insulation shall be the following:
a. 1-1/2 inches and Smaller: 1-inch thick.
b. 2-inches and larger: 2-inches thick.

D. Heating-Hot-Water Supply and Return, 200 Deg F and below:
1. Mineral-Fiber, Preformed Pipe, Type I. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF. Insulation shall be the following:
a. 2-inches and Smaller: 1 inch thick.
b. 2-1/2-inches and Larger: 1-1/2 inches thick.

E. Refrigerant Suction and Hot-Gas Piping:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF. Insulation shall be the following:

F. Hot Service Drains:
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe, Type I or II: 3/4 - inches thick. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF. Insulation shall be the following:

G. Hot Service Vents:
1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I or II: 3/4 - inches thick. Thermal Conductivity (K value): Not greater than 0.23 at mean temperature of 75 degF. Insulation shall be the following:

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Heating-hot-water expansion/compression tank, air-separator and chemical feeder:
1. Aluminum jacket, smooth, 0.016 inch thick.

D. Piping, Exposed in mechanical rooms and central plant less than 8-feet above floor :
1. PVC: 30 mils thick.

END OF SECTION 230700

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230700 - HVAC INSULATION.DOC

SECTION 230800 – HVAC SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment testing and start-up

B. Validation of proper and thorough installation of Division 23 (HVAC) systems and equipment

C. Systems balancing verification

D. Prefunctional performance testing of equipment and systems

E. Documentation of tests, procedures, and installations

F. Coordination of Training Events

G. Generic Start-Up Procedures for plumbing systems and equipment

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) is retained by the Owner shall work with the Contractor and the Design Engineer to direct and oversee the Cx process and perform functional performance testing.

C. This Section outlines the Cx procedures specific to the Division 23 Contractors. Requirements common to all Sections are specified in Sections 019113 and 019114 and the Cx Plan.

1.3 SCOPE

A. The following are included in the Scope of Commissioning on this project:

B. HVAC Systems

1. Boilers
2. Chillers
3. Cooling Towers
4. Pumps
5. CHW/HW distribution systems
6. Air Handling Units (AHU)
7. Terminal Units

8. Phoenix valves
9. Split systems
10. Misc supply and exhaust fans and terminal equipment

C. Building Automation Systems

1. Refer to Section 230995.

1.4 RELATED WORK AND DOCUMENTS

A. Section 019113 – General Commissioning Requirements: details the Cx requirements common across all divisions

B. Section 019114 – Functional Testing Procedures: Outlines the generic functional testing procedures required.

C. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

D. Section 230995 – Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.

E. Section 260800 – Electrical Systems Commissioning: Details the commissioning procedures specific to Division 26 work.

F. Section 280820 – Fire Alarm Systems Commissioning: Details the commissioning procedures specific to Division 28 Fire Alarm work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113

1.6 REFERENCE STANDARDS

A. ASHRAE Guideline 1-1996, "Guideline for Commissioning HVAC Systems"

B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”

C. NEBB – Procedure Standards for Building Systems Commissioning

1.7 DOCUMENTATION

A. In addition to the documentation required in Section 019113, Contractor shall provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Balancing Plan: The plan shall include the following:

a. Certification on all instrumentation to be used throughout the testing; this must document certification within the last 6 months.
b. Résumés and Certification of individuals who will be balancing systems
c. Detailed step by step plans for each procedure to be performed
d. Sample forms to be used for each measurement
e. Sample balancing report

2. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format. These may include but are not limited to:

a. Air Handling Units
b. Chillers
c. Variable Frequency Drives
d. Fans Capacity
e. Boilers
f. Pump Capacity

3. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in pdf electronic format. These may include but are not limited to:

a. Pipe Pressure Testing
b. Duct Leakage Testing
c. Water Treatment

4. Completed Test and Balance Reports; CA will review prior to FPT.

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 23.

B. Construction Phase

1. Provide skilled technicians qualified to perform the work required.
2. Provide factory-trained and authorized technicians where required by the Contract Documents.
3. Prepare and submit required draft Start-Up Procedures and submit along with the manufacturer's application, installation and start-up information.
4. TAB: As outlined in testing and balancing specification. Specifically as it relates to Cx:

a. Attend Cx kick-off meeting and Cx progress meetings held within 3 months of and during Acceptance Phase.
b. Submit Balancing Plan as indicated above
c. Meet with Cx Team to review TAB procedures and documentation required.
d. As called by CA, participate in CxT demonstrations of balancing procedures for repetitive procedures such as zones.
e. Attend a meeting convened by the C to coordinate with the Safety certifying agency. The point of the meeting will be to coordinate protocols and measurement approaches to

ensure that devices such as Fume Hoods and Biosafety cabinets will be set up to achieve certification

f. Participate in Action List dialogue
g. Provide all documentation electronically.

5. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
6. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
7. Start-up, and test/adjust/balance systems and equipment prior to functional performance testing by the CA. Start-Up Procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
8. Record Start-up Procedures on start-up procedure forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.

C. Acceptance Phase

1. Assist CA in functional performance testing. Assistance will generally include the following:

a. Manipulate systems and equipment to facilitate testing (as dictated in Section 019114; in some cases this will entail only an initial sample);
b. Provide any specialized instrumentation necessary for functional performance testing;
c. Manipulate BAS and other control systems to facilitate functional performance testing (as dictated Section 019114, Section 230995, and the Cx Plan; in some cases this will entail only an initial sample).
d. Provide a TAB technician to work at the direction of CA.
e. Provide a BAS technician to work at the direction of CA.

D. Warranty Phase

1. Maintain record documentation of any configurations, set ups, parameters etc, that change throughout the period.
2. Provide representative for off season testing as required by CA.
3. Respond to Warranty issues as required by Division 1 and the General Conditions.

1.9 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

1. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of + or - 0.1°F.
2. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
3. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems shall be provided by CA.

C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

2.3 TEST KITS FOR METERS AND GAGES

A. Test kits for meters and gages shall be provided to the Owner new and in good condition. Previously used kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits included shall be as a minimum:

1. Digital indication of temperature and pressure with associated sensors to work with the P/T test ports
2. Companion readout kit (with fittings) for calibrated balancing valve with ranges as required by all devices on this project

PART 3 - EXECUTION

3.1 START-UP PROCEDURES - GENERAL

A. Part III of this Section outlines 'generic' or minimally acceptable Start-Up Procedures (delineated as Start-Up Checks and Start-Up Tests) and individual systems Training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimum or guideline for required Contractor development of Start-Up Procedures. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized Start-Up Procedures specific to the equipment and systems installed on this project.

3.2 PROCEDURES COMMON TO ALL SYSTEMS

A. The following start up verifications/procedures are common to all systems

B. Checkout shall proceed from devices to the components to the systems.

C. Verify labeling is affixed per spec and visible

D. Verify prerequisite procedures are done.

E. Inspect for damage and ensure none is present.

F. Verify system is applied per the manufacturer's recommendations

G. Verify system has been start up per the manufacturer's recommendations

H. Verify that access is provided for inspection, operation and repair

I. Verify that access is provided for replacement of the equipment

J. Verify the record drawings, submittal data and O&M documentation accurately reflect the installed systems

K. Verify all gages and test ports are provided as required by contract documents and manufacturer's recommendations

L. Verify all recorded nameplate data is accurate

M. Installation is done to ensure safe operation and maintenance.

N. Verify specified replacement material/attic stock has been provided as required by the Construction Documents

O. Verify all rotating parts are properly lubricated

P. Verify all monitoring and ensure all alarms are active and set per Owner's requirements

Q. Complete all nameplate data and confirm ratings conform with the design documents

3.3 VALVES

A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
2. Verify actuators are properly installed with adequate clearance.
3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable. For electronically operated valves, check the stroke and range. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.4 METERS AND GAGES

A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Adjust faces of meters and gages to proper angle for best visibility.
2. Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gages requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
3. Meters and gages requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION

A. Start-Up Checks: Perform the following checks:

1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
2. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
3. Cleaning: Clean face of identification devices, and glass frames of valve charts

3.6 MECHANICAL INSULATION

A. Start-Up Checks: Examine all piping, systems and equipment specified to be insulated.

1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.
2. Ensure the integrity of vapor barrier around all cold surfaces.

3.7 PIPING - GENERAL

A. Start-Up Checks: These Procedures apply to all installed piping systems, including underground site utilities.

1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.
3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
4. Provide notification of pipe cleaning and flushing activities
5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
6. Ensure adequate drainage is provided at low points and venting is provided at high points.
7. Ensure air is thoroughly removed from the system as applicable. Ensure facilities to effectively drain and fill the system are in place.
8. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
9. Provide notification of pressure testing
10. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
11. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
12. Submit pressure test reports that document the pressure testing results with Certification of the results.
13. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
14. Set and adjust fill, pressure, or level controls to the required setting.

3.8 AC MOTORS

A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:

1. Verify proper alignment, installation, and rotation.
2. Verify properly sized overloads are in place

B. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:

1. Measure insulation resistance, phase balance, and resistance to ground
2. Measure voltage available to all phases; measure amps and RPM after motor has been placed in operation and is under load.
3. Record all motor nameplate data.

3.9 BEARINGS

A. This applies to all bearings on fans, pumps, compressors, etc.

B. Check alignment as applicable

C. Lubricate all bearings per the manufacturer’s instructions. When bearing is used for temporary conditioning, lubricate on manufacturer’s recommended frequency and document it.

3.10 VARIABLE SPEED DRIVES

A. General: Provide the services of a factory authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

B. Start-Up Checks: Perform the following checks before start-up and as specified in manufacturer's start-up instructions:

1. Check unit for shipping damage.
2. Perform a point-to-point continuity test for all field installed wiring interconnections. Verify terminations of field installed wiring.
3. Check for proper torque on connections.
4. Verify use of shielded cable where specified and check that shields have been terminated properly.
5. Verify grounding.
6. Check motor nameplate against drive input rating.
7. Manually rotate motor shaft to ensure free rotation.
8. Check that motor leads are not grounded.

C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:

1. Ensure device and system which drive is serving is configured to withstand the device operation specified below.
2. Adjust the Minimum Voltage Adjustment to enable starting but not to draw excessive power at start.
3. Adjust the Volts/Hz adjustment to proper setting.
4. Adjust the Acceleration and Deceleration rates to the specified times.
5. Adjust Current Limiting to coordinate with the overcorrect device and protect the motor.
6. Set the Maximum and Minimum speed pots.
7. Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration
8. Determine any critical speeds to avoid and set these in the drive.
9. Check for acceptable voltage and current distortion on the power system. Record the input and output voltages and currents showing the harmonic content as a percentage of the base frequency.
10. Measure and record overall efficiency at 50%, 75%, and 100%
11. Record the motor terminal voltage.

D. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

1. Review data in Operating and Maintenance Manuals.

3.11 NATURAL GAS SYSTEMS

A. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.
2. Submit draft test forms and completed test forms to document and certify test results.

3.12 HYDRONIC PIPING

A. Start-Up Checks: Perform the following checks:

1. Prepare hydronic and test piping in accordance with applicable Section and ASME B 31.9 and/or B 31.1
2. Flush system with clean water in accordance with applicable Section.
3. Clean strainers.
4. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
5. Set automatic fill valves for required system pressure.
6. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
7. Set and coordinate automatic fill pressure and relief valve settings

B. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.13 STEAM AND CONDENSATE PIPING

A. Start-Up Checks: Perform the following checks:

1. Prepare hydronic and test piping in accordance with applicable Section and ASME B 31.9 and/or B 31.1
2. Flush system with clean water in accordance with applicable Section.
3. Clean strainers.
4. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
5. Set automatic fill valves for required system pressure.
6. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
7. Set and coordinate automatic fill pressure and relief valve settings

B. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.14 REFRIGERANT PIPING

A. Start-Up Checks: Perform the following:

1. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation.
2. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI.
3. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
4. Clean and inspect refrigerant piping systems in accordance with the applicable section
5. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

B. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

3.15 PUMPS

A. Refer to AC Motors in this section

B. Refer to Bearings in this section

C. Refer to Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

D. Start-Up Checks: Perform the following checks before start-up:

1. Check suction lines connections for tightness to avoid drawing air into the pump.
2. Clean and lubricate all bearings.
3. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
5. Clean associated strainers.
6. Check that the proper overloads have been installed in the starter and are the correct size.
7. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections.
8. Align pump within manufacturers recommended tolerances.
9. Ensure all associated piping has been cleaned, tested, and vented.
10. Verify that all thermometers and gages are installed, are clean and undamaged, and are functional.

E. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:

1. Start the pump per the manufacturer’s instructions.
2. Check the general mechanical operation of the pump and motor.
3. Verify that check valve seal is appropriate.

4. Check noise and vibration levels and ensure they are within the manufacturers recommended tolerances.
5. Check that the NPSH is with that allowable for the operating condition.
6. Refer to Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.16 BREECHINGS, CHIMNEYS, AND STACKS

A. Start-Up Checks: Perform the following checks:

1. Clean breechings internally during installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.
2. Check to ensure adequate draft throughout firing range and with all variations of multiple boilers

3.17 FEEDWATER EQUIPMENT

A. Refer to AC Motors in this section

B. Start-Up Tests: Perform the following before or during start-up:

1. Start up feedwater equipment, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.18 AIR-COOLED CONDENSING UNITS

A. General: Provide the services of a factory authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

B. Refer to AC Motors in this section

C. Start-Up Checks: Perform the following inspections/checks before start-up:

1. Ensure unit is level
2. Coils are undamaged and fins are combed
3. Condenser fan rotates freely and check rotation direction

D. Start-Up Tests: Perform the following before or during start-up:

1. Start up condensing units, in accordance with manufacturer's start-up instructions.
2. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
3. Charge systems with refrigerant and oil, and test for leaks. Repair leaks and replace lost refrigerant and oil.

E. Training: [Factory-authorized representative] [Contractor] shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals

3.19 CENTRIFUGAL CHILLERS - WATER COOLED

A. General: Provide the services of a factory authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below. Representative shall provide a written report documenting the start-up.

B. Refer to Bearings in this Section

C. Start-Up Checks: Perform the following inspections/checks before start-up:

1. Ensure that all associated piping is cleaned, tested, filled, and deaerated.
2. Ensure that refrigerant/oxygen monitoring and safety controls are started and functional.
3. Inspect the installation and access/clearance for service and maintenance to ensure it meets the project and manufacturer’s requirements
4. Check control interfaces for proper ranges and approve the interface

D. Start-Up Test and Service:

1. Provide the services of a factory authorized service representative to provide startup service.
2. Evacuate, dehydrate, vacuum pump and charge with specified refrigerant, and leak test in accordance with manufacturer's instructions. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
3. Optimize chiller charge and operating characteristics
4. Log machine parameters at various load, at a minimum 25%, 50%, 75%, and 100%
5. Perform lubrication service, including filling of reservoirs, and confirming that lubricant is of quantity and type recommended by manufacturer.
6. Submit factory start-up report per specifications.

E. Training: Factory-authorized representative shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals

3.20 FACTORY-FABRICATED COOLING TOWERS

A. Refer to Bearings in this Section

B. Start-Up Checks: Perform the following inspections/checks before start-up:

1. Cleaning: Ensure inside of cooling tower is cleaned thoroughly before filling for start-up. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
2. Inspect the installation and access/clearance for service and maintenance to ensure it meets the project and manufacturer’s requirements
3. Verify lubrication of rotating parts; lubricate as needed.

4. Verify fan rotation direction.
5. Verify that motor amperage is in accordance with manufacturer's data.

C. Start-Up Tests: Perform the following before or during start-up:

1. Comply with manufacturer's instructions for filling and start-up of operation.
2. Balance condenser water flow to each tower, and to each inlet for multiple inlet towers.
3. Adjust water level control for proper operating level.
4. Adjust temperature controls and verify operation.
5. Operation Test: Test each cooling tower to show that it will operate in accordance with indicated requirements.

3.21 TERMINAL UNITS

A. Start-Up Checks: Perform the following inspections/checks before start-up:

1. After construction is completed, including painting if applicable, clean unit exposed surfaces.
2. Vacuum-clean terminal coils and inside of cabinets.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
4. Verify adequate access for maintenance.
5. Check power and control voltages.
6. Check rotation of fan where applicable.
7. Check calibration and operation of the controlling elements.
8. Check control valves for required close-off and fail position.
9. Install new filter units for terminals requiring same.

3.22 VAV TERMINAL UNITS

A. Refer to and coordinate with Section "Testing, Adjusting, and Balancing"

B. Start-Up Checks: Perform the following inspections/checks before start-up:

1. After construction is completed, including painting if applicable, clean unit exposed surfaces.
2. Clean factory-finished surfaces. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
3. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.
4. Ensure that air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.
5. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable). Measure and record motor amperage and voltage
6. Ensure the coils are undamaged, combed, and vented.
7. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure it closes and seals tightly.

C. Start-Up Tests: Perform the following before or during start-up:

1. Calibrate and adjust the airflow control parameters. Set applicable min and max setpoints. Coordinate with the ATC contractor as necessary to obtain flow parameters required.

2. Install new filters where required.
3. Set all temperature and humidity setpoints to those as directed by Owner.
4. Record supply air temperature at full cooling and at full heating (compare both with current air handler temp)

3.23 FLOW TRACKING VAV TERMINAL UNITS

A. All Start-Up Procedures for 'VAV Terminal Units' shall apply.

B. Start-Up Tests: In addition, for Flow Tracking VAV terminal units:

1. Meet with CA to establish the protocol for zone set up.
2. Measure zone differential pressure in all max and min conditions (max and min cooling, max and min heating, max and min hood sash as applicable)
3. Ensure flow variations do not cause reverse pressurization in the space.

3.24 CENTRAL-STATION AIR-HANDLING UNITS

A. Provide the services of a factory authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

B. References: The following additional Sections shall also apply:

1. Refer to AC Motors in this Section.
2. Refer to Fans in this Section
3. Refer to Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
4. Refer to Division 230995 Section "BAS Commissioning" for procedures for starting the controls related to the AHU.

C. Start-Up Checks: Perform the following inspections/checks before start-up:

1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Cleaning: Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
3. Adjust and lubricate dampers and linkages for proper damper operation.
4. For field fabricated units, ensure the sections are properly connected within acceptable tolerances.
5. Seal the all penetrations air tight and ensure access doors seat tightly.
6. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete.
7. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
8. Ensure vibration isolation integrity is maintained throughout the AHU installation and its connections.
9. Tension all belts per the drive manufacturer's recommendations.
10. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

11. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
12. Comb coil fins for parallel orientation.
13. Install clean filters.
14. Ensure condensate drains properly and that trap is adequate.
15. Stroke all valves and damper to ensure free and full travel

D. Start-Up Tests: Perform the following before or during start-up:

1. Pressure test units as required in the AHU specification

E. Training: [Factory-authorized representative] [Contractor] shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals

3.25 FANS

A. References: The following additional Sections shall also apply:

1. Refer to AC Motors in this Section.
2. Refer to Bearings in this Section
3. Refer to Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
4. Refer to Division 230995 Section “BAS Commissioning” for procedures for starting the controls related to the AHU.

B. Start-Up Checks: Perform the following inspections/checks before start-up:

1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
3. Adjust and lubricate dampers and linkages for proper damper operation.
4. Verify unit is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
5. Ensure vibration isolation integrity is maintained with the fan installation and the connections to it
6. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
7. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
8. Stroke all dampers to ensure free and full travel

C. Training: Contractor shall train Owner's maintenance personnel including:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.

2. Familiarization with contents of Operating and Maintenance Manuals

3.26 METAL DUCTWORK

A. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

B. Start-Up Checks: Perform the following checks before start-up and as specified:

1. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
2. Strip protective paper from stainless ductwork surfaces if applicable, and repair finish wherever it has been damaged.

C. Start-Up Tests: In addition to specifications, perform the following as a minimum:

1. Leakage Tests: After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.
2. Balancing: Refer to section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

3.27 DUCTWORK ACCESSORIES

A. Start-Up Checks: Perform the following checks before start-up and as specified:

1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

B. Start-Up Tests: In addition to specifications, perform the following as a minimum:

1. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.
2. Label access doors in accordance with section "Mechanical Identification".
3. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
4. Final positioning of manual dampers is specified in section "Testing, Adjusting, and Balancing".
5. Fire Damper Testing: For every fire damper, remove the fusible link and verify that the damper operates freely and closes tightly. Reinstall the fusible link.

3.28 AIR TERMINALS

A. Start-Up Checks: Upon completion of installation and prior to initial operation, check that air terminals are:

1. Properly installed with the proper airflow direction
2. Properly supported with vibration isolation integrity maintained where applicable
3. Duct connections to air terminals are leak-tight.
4. Operable dampers travel free.
5. Airflow measuring devices are properly installed and connected.
6. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.
7. Clean exposed factory-finished surfaces; repair any marred or scratched surfaces with manufacturers touch-up paint.

3.29 BUILDING AUTOMATION AND CONTROL SYSTEMS

A. Start-Up Checks: Perform the following checks before start-up and as specified:

1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

B. Start-Up Tests: Refer to Section 230995 BAS Commissioning. This generally requires manufacturers authorized representative to start-up, test, adjust, and calibrate direct digital and other microprocessor-based control systems and demonstrate compliance with requirements. This will include verification of sequences, normal and emergency operations, calibration, interfaces, and interlocks, etc.

3.30 TESTING, ADJUSTING, AND BALANCING

A. Reference: Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the respective section and the referenced standards.

B. Start-Up Checks: In addition to specifications, perform the following as a minimum:

1. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
2. Patch insulation, ductwork, and housings, using materials identical to those removed.
3. Seal ducts and piping, and test for and repair leaks.
4. Seal insulation to re-establish integrity of the vapor barrier.
5. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
6. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
7. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards.

C. Training:

1. Train the Owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures.
2. Review for the Owner’s personnel the locations of TAB reports and data.

3.31 ROOM/ZONE CHECKOUT

A. Contractor shall complete a checklist acknowledging completion of Div. 23 responsibilities for all rooms. Checklist shall include items such as the following as applicable:

B. Typical Room:

1. Diffuser, registers, and grilles installed and cleaned
2. Zone Control in place and functional
3. All terminal equipment functional, clean, and punched out
4. Occupancy schedules entered with applicable control setpoints

C. Rooms with Plumbing Fixtures

1. Plumbing fixtures clean and operational

D. Laboratories

1. Fume hoods and BSC's cleaned, adjusted, and operating in range
2. Eye Washes and emergency showers functional with all actuators in place
3. All air, gas, and vacuum turrets checked and functional with report on cross contamination
4. Air Pressurization validated. Monitors are in place per design documents.

3.32 SEQUENCING ILLUSTRATION

A. Reference Section 019113

END OF SECTION 230800

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The uniform general conditions, supplementary general conditions, and Division 1 of the Specifications apply to the work specified in this Section.

1.2 INTRODUCTION

A. Overview

1. This document contains the specification for a Direct Digital Control (DDC) system, also commonly termed the Building Automation System (BAS).

B. Instructions To Bidders

1. Base Bid – Include all work as described in the specification and drawings.

C. It is the Owner's requirement that the DDC System Suppliers will bid all parts of the project. Failure to bid on any part of the project may result in bid being rejected.

D. This document lists the requirements for the procurement of a DDC system for the entire project over a period of time.

1. The DDC System Supplier will have a contract directly with the Mechanical Contractor.

E. Approved DDC System Suppliers

1. Allerton, Inc.

2. Siemens

3. Automated Logic Corporation

4. Pritchett-Reliable.

1.3 STIPULATIONS

A. Applicable requirements of the General Conditions and special requirements and Division 1 are part of this section and shall have the same force and effect as if printed here within full.

B. In case of conflict between various requirements, the most stringent requirement shall apply.

C. The complete construction documents package for the work that is included in this project's work is being provided. It is the bidder's responsibility to ensure that they have indeed received all of the documents as listed in this specification.

1.4 PURPOSE OF THIS DOCUMENT

A. The purpose of this document is to obtain a lump sum price for the project.

B. The technical requirements for the DDC System are generally included in this document. Failure by the bidder to adhere to these requirements may result in their bid being rejected.

C. It is to be understood that the Owner is generally looking for the system as listed in this document. Any deliberate attempt by the bidders to "cheapen" the system by extensive use of unitary controllers on large equipment (air handling units, heat exchangers, etc.) may render the bid as invalid.

D. The Owners and Engineers, at their discretion, may ask for further information and/or clarification from the DDC supplier. Any written communication between the DDC System Suppliers and the Owner and/or Architect/Engineer may be included as part of the final contract between the Owner and the DDC System Supplier.

E. If DDC system improvements occur between the time the of the existing installation and the time the Bid Documents are issued, and if these improvements require significant changes in the proposed system architecture, the Owner must approve such changes before the submission of the bids. Any system improvements or enhancements must be presented to the owner, whether the intent is to use the enhanced systems on this project or not.

F. It is to be understood that the Owners are not obligated to accept the bid and the Owners reserve the right to reject the bid without explanation.

G. All costs incurred by the DDC System Suppliers and their representatives for the preparation of the bid is their own responsibility. The Owner is not responsible for any of these costs.

1.5 REQUIREMENTS FOR SUBMITTING BIDS

A. The bids must provide complete details for all equipment proposed sensors, hardware, software, and other equipment as specified. The material shall be carefully organized so that an accurate evaluation can be made.

B. The schematic system layout shall show complete system architecture, including all digital control panels (DCPs) required. (It is to be noted that the installation drawings should show enough details so that an installation contractor can provide the wiring and labeling.) Show location of all DCPs, UCs, operator devices, etc. (This is to include the existing controller and workstation.)

1.6 DESCRIPTION OF PROJECT SITE

A. Refer To General Conditions

1.7 ABBREVIATIONS

A. Below is a list of abbreviations related to this project:

ACP	Apparatus Control Panel
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
AI	Analog Input
ANSI	American National Standards Institute
AO	Analog Output
ASME	American Society of Mechanical Engineers
AWG	American Wire Gauge
BI	Binary Input
BO	Binary Output
CFM	Cubic Feet per Minute
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DCP	Digital Control Panel
DDC	Direct Digital Control
DE	Data Environment
DI	Digital Input
DO	Digital Output
DP	Differential Pressure
DPDT	Double Pole Double Throw
DPST	Double Pole Single Throw
DTC	Data Terminal Cabinets
EA	Exhaust Air
EIA	Electronic Industries Association

EMT	Electrical Metallic Tubing
EMS	Energy Management System
E/P	Electric/Pneumatic Transducer
EPROM	Erasable Programmable Read Only Memory
FCC	Federal Communication Commission
FPM	Feet per Minute
FV	Face Velocity
GPM	Gallons per Minute
HVAC	Heating, Ventilation and Air Conditioning
I&C	Instrumentation and Control
I/O	Input/Output
I/P	Current to Pneumatic
IEEE	Institute of Electrical and Electronic Engineers
ISA	Instrument Society of America
kWH	Kilowatt Hours
LAN	Local Area Network
MFA	Master Fire Alarm
N.C.	Normally Closed
NIP	Network Interface Panels
N.O.	Normally Open
NEC	National Electrical Code
OA	Outdoor Air
PDL	Peak Demand Limiting
P/E	Pneumatic/Electric
PLC	Power Line Conditioner
PUP	Non-Proprietary Public Unitary Protocol
PROM	Programmable Read Only Memory
RA	Return Air
RAM	Random Access memory
RH	Relative Humidity
RTC	Real Time Clock
RTD	Resistance Temperature Detector
SA	Supply Air
SWH	Service Water Heating
SPDT	Single Pole Double Throw
SPST	Single Pole Single Throw
TBG	Time Base Generator
UCP	Unitary Control Panel (also called application specific controllers or UC Controllers)
UL	Underwriter's Laboratory
VAV	Variable Air Volume

1.8 DEFINITIONS

A. Terms

1. **(adj):** This acronym is used for the word "adjustable". It is used in conjunction with the definition of an application parameter that resides in a Building Controller, Advanced Application Controller or Application Specific Device. Example: The hot water set point shall vary as a function of the outside air temperature. When the outside air temperature is 0 F (adj), the hot water set point shall be 180 F (adj). When the outside air temperature is 60 F (adj), the hot water set point shall be 100 F (adj). In this example, four variables have been defined as adjustable. When so defined, these variables must be exposed to the field bus as BACnet objects for viewing by a BACnet OWS.

2. **Actuator:** Control device to provide motion of a valve or damper in response to a control signal.

3. **A/D Converter Resolution:** The resolution of an analog to digital converter is the voltage range of the A/D divided by 2 to the X power where X is the number of bits for the A/D converter.

4. **Advanced Application Controller:** A controller with provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air-handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that is associated with the physical inputs to the physical outputs. A process controller may or may not have data management features such as time schedules, trend data storage and alarm message generation capabilities. These features may be provided by the Building Controller.

5. **AI:** Analog Input

6. **Alarm Handling:** The process by which the existence of an alarm condition results in the dispatch of an editable message to one or more operator workstations.

7. **Algorithm Execution Sample Rate:** How often a mathematical algorithm in a controller generates a new output value.

8. **Analog:** Continuously variable state over a stated range of values.

9. **Analog Calibration Offsets:** For all analog input measured variables, there is a requirement to adjust the value measured by the hardware based analog input point to match the value reported by a certified test instrument. An analog calibration offset is a parameter that can be added or subtracted from the raw value measured by the sensor to produce a calibrated value that will be use by the control logic and reported to the operator workstations. The initial value of this parameter is set at zero and it is adjusted when the calibration process is executed. This adjustment is referred to as a single point calibration. These offset values are configuration parameters and as such shall be written to EEPROM. It shall be possible to change the value of these parameters without re-downloading the program to the controller.

10. **AO:** Analog Output

11. **Application Programming Tool (APT):** A software tool used to create control logic for use in a Building Controller or Advanced Application Controller (Process Controller or Supervisory Logic Controller). Application programming tools are unique to each vendor. Example: The Honeywell application programming tool cannot be used to create an application for downloading to a TAC programmable process controller. The use of open protocols does not impact this definition.

12. **Application Specific Controller (ASC):** A subset of application specific devices (ASD).

13. **Application Specific Device (ASD):** A sensor, controller, or end device that is pre-programmed by the vendor. It may have physical inputs and physical outputs. The control logic, while not programmable, may be configurable through the use of configuration parameters. The application may require input network variables and may send output network variables onto the network.

14. **Approve**: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in the Conditions of the Contract. Such "approval" does not release the General Contractor from the responsibility to fulfill the Contract Document requirements.

15. **Approved equal**: to be defined in the specification.

16. **Archive:** Long term storage of historical data. Archived data may be on the hard drive or relocated to disk or tape.

17. **ATS:** Automatic Time Schedules. Automatic time schedule software measures time and executes start and stop commands based on operator created requirements that are based on the day of the week or the date.

18. **AWG:** American Wire Gauge – Standard trade sizes of conductors

19. **B-AAC:** BACnet Advanced Application Controller

20. **B-ASC:** BACnet Application Specific Controller

21. **B-BC:** BACnet Building Controller

22. **B-OWS:** BACnet Operators Workstation

23. **B-SA:** BACnet Smart Actuator

24. **B-SS:** BACnet Smart Sensor

25. **BACnet:** Building Automation and Control Networks

26. **BIBBS:** BACnet Interoperability Building Blocks

27. **Broadcasting:** The propagation of data from a device to the control network. Software objects that broadcast data to the network may include the following parameters:

    a. **Send on Delta:** An adjustable parameter that defines a requirement to broadcast when the data generated by the software object changes by an amount that exceeds this parameter's value. For binary data, this parameter defaults to a change of state. The broadcast of data is initiated when this criteria and the minimum send time requirement have been met. Also referred to as a "Change of Value".

    b. **Minimum Send Time:** An adjustable parameter that defines a mandatory time period during which no broadcasting of data will occur. Once this time period has been exceeded without a broadcast, the send on delta parameter or the maximum send time parameter shall determine when a broadcast is initiated.

    c. **Maximum Send Time:** An adjustable parameter that defines the maximum time period between broadcasts of a software object's data to the network. Should the value of a software object remain constant over an extended period of time, the value will be rebroadcast once every maximum time period.

28. **Building Controller:** A device that includes IP to Field Bus router, automatic time scheduling, trend logging, alarm handling, and supervisory logic control functionality. Sometimes referred to as a BACnet Building Controller or B-BC.

29. **Building Project Manager**: is the Owner's manager for the particular building project.

30. **Bus Topology:** A term used to describe the sequential connection of devices on a LON segment. The communication cable runs from device to device with no tees or stubs from the main communication cable to a device. Also referred to as daisy chain wiring.

31. **CAT:** Category 5 Cable or Category 6 Cable – is an ANSI/EIA Standard 568 that specifies categories of twisted pair cabling systems (wire, junctions, and connectors) in terms of the data rates that they can sustain.

32. **CFM:** Cubic Feet per Minutes

33. **Concurrent Personnel Training**: is to mean adding one more trainee to the number of trainees specified. This trainee will be assumed to be added to the same training class as specified.

34. **Configuration Parameter:** An input variable to a device that is written to EEPROM. Configuration parameters can be changed from the OWS periodically but are not changed routinely as a function of control logic.

35. **Control Room**: the central station for the DDC system. This room shall also mean central control station, or central control center.

36. **Coordination**: the DDC System Supplier shall meet with the Engineer and Owner during the design stages of each building to coordinate the work of the DDC System installation

37. **Data Server:** A personal computer with a Microsoft's Sequel database for the storage of historical data. The historical data is sent to the data server by the system servers.

38. **Data Storm:** A data storm is the uncontrolled transmission of data from a controller to the network. It can consume bandwidth and prevent necessary data from getting through. It is typically caused by poorly written applications that do not use event driven communication with minimum send times, send on delta (change of value), and maximum send time parameters.

39. **Data Terminal Cabinets**: this is a slave or extender panel to the DCP. This panel usually does not operate without being connected to the DCP.

40. **Dead Zone:** With respect the performance of a PID algorithm, the dead zone is the range of an input variable to the PID above and below the set point for which the output of the PID algorithm shall not be changed. Once the input variable gets within the dead zone, it is fruitless to attempt changes to get the input variable any closer to the set point. Assigning a dead zone to a PID loop improves stability and reduces wear and tear on the actuator.

41. **DDC System Installer**: the contractor who is to install all equipment, which is furnished by the specification. The DDC System Installer will provide all wiring, pneumatic tubing and conduit, which are required by the specification unless otherwise noted.

42. **DDC System Manufacturer**: this term shall mean the same as DDC System Supplier and vice versa.

43. **DDC System Project Manager**: is the main contact person who is employed by the DDC System Supplier and is responsible for all DDC matters concerning this project.

44. **DDC System Supplier**: the contractor who is to furnish all equipment required by the specification.

45. **DI:** Digital Input. Also referred to as a binary input or discrete input.

46. **Digital Control Panel**: this is the highest level of equipment that is connected directly to the high speed local area network. The DCP may or may not have I/Os connected to it. (DCP is also referred to as NIP on the Construction Documents.)

47. **Directed**: Terms such as "directed," "requested," "authorized," "selected," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases. However, no implied meaning shall be interpreted to extend the Engineer's responsibility into the Contractor's area of construction supervision.

48. **Discrete:** Binary or digital state

49. **DO:** Digital Output. Also referred to as a binary output or discrete output.

50. **Drift:** When a sensor calibration is checked after a defined period of time (typically one year), the difference between the reported value and the measured value is defined as the drift. This measurement assumes that the sensor was calibrated at the beginning of the time period. If the measurement at the end of the time period is at a different value than the measurement at the beginning of the time period, an allowance for the conformity rating must be included.

51. **Dynamic Data:** Data in a field level device that periodically changes values due to the measurements from the physical environment or the execution of control logic.

52. **EEPROM:** Electrically Erasable Programmable Read-Only Memory (ROM) that can be erased and reprogrammed (written to) repeatedly through the application of higher than normal electrical voltage.

53. **Electronic Signature:** Electronic signature is a feature that supports certification under 21 CFR Part 11. When an operator that is signed onto a system takes an action such as changing a set point, the system requires the user name, password and a documented reason for the action before the action is allowed to take affect.

54. **Enforced Acknowledged Response:** When an alarm is acknowledged, the entry of the cause of the alarm, action taken to resolve the alarm state, and additional comments are required.

55. **Engineer** or **Architect:** the Project Engineer for various projects. For the DDC System project, the Engineer shall be Burt Hill. The term "Architect" shall be deemed to mean "Engineer" unless otherwise noted. The Engineer will be responsible for all work which is in design. It may be necessary for the DDC System Supplier to coordinate with the Engineer's subcontractors during design and construction.

56. **Event Driven Communication:** A term used to describe the propagation of data from a device to the network based on broadcasting rather than polling. The send on delta (change of value) parameter is used to define the event and the data propagation is further controlled by the minimum and maximum send time parameters.

57. **Existing: "**Existing" equipment or devices shall remain in service unless otherwise noted. All equipment that is not indicated as being existing shall be new.

58. **FC:** Failed close position of a control device or actuator. The device shall move to the closed position on a loss of the control signal or energy source.

59. **Firmware:** There are two types of software associated with a hardware device. The first element of software provides the underlying core functionality of the device. The second element is the application program that allows the device to execute a specific sequence of control. The first core element is typically revision sensitive and may be updated from time to time by the vendor to improve performance. This first element of software is called firmware.

60. **Floating Control:** Floating control is a control loop algorithm used for fast responding airside and waterside pressure and flow control loops. Defining a set point and a neutral zone creates a "floating" analog zone in units of the process variable. The neutral zone is split half above the set point and half below the set point. Whenever the process variable is within the "floating" zone, the actuator is left unchanged (stationary for tri-state actuators and at the current percent stroke for analog devices). The process variable is measured and the algorithm executed once for each sample rate. For tri-state devices, the sample rate is always 1 second. For analog devices, the sample rate will vary from 2 to 10 seconds (a tuning requirement). During the execution of the algorithm, if the process variable is above or below the "floating" zone, the instructions to the end device are changed. For tri-state devices they are put into motion. For analog devices, their percent stroke signal is either increased or decreased by a set amount (called the bump rate). One

sample rate later the process is repeated. If the process variable has returned to within the "floating zone," a tri-state actuator is instructed to cease motion and an analog device will hold at the new percent signal sent on the last sample. If the process variable remains outside the "floating" zone, a tri-state device will continue in motion and an analog device will receive another "bump". With pressure based control loops, it is usually required to set the position of the control device to a fixed level for a period of time when the system is started. This will preclude a pressure spike in the first few minutes of operation. This is not required for flow control loops.

61. **Flyover:** When the linking object is "transparent", information about the link is viewable only when the operator moves the pointer over the transparent linking object. This process is called a "flyover". A transparent linking object might be placed over a bitmap picture of a piece of equipment. When the operator moves the pointer over the picture of the piece of equipment the link is viewable and clicking on the link takes the operator to the graphic page for the piece of equipment.

62. **Free Topology:** A data wiring topology supported by LON that allows for loops, tees, y-connections, etc. When this topology is used, only one terminator of a specific design is required and allowable cable lengths are significantly reduced. Guidelines on the application of this concept are available from Echelon.com.

63. **Furnish**: The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."

64. **Gain:** A term used with proportional control. Gain is 100 divided by the specified throttling range. See also the definition for throttling range. This term is sometimes referred to as the proportional gain.

65. **Graphic Page:** A graphic page is a visual presentation in the operator workstation that allows the operator to view a collection of data in an organized manner. The data on a single view can come from multiple field devices. The data can be organized in a table format within the view. The data can be displayed on a visual representation of a mechanical system. Both visual equipment displays and columns of data can be displayed on single view. Links to other graphical pages can be displayed. Links to IP addresses can be displayed on a graphic page. A graphic page can be static such as a site map or picture with no dynamic data only links to other graphic pages.

66. **Graphical Programming:** Graphical programming is a concept where mathematical and logical algorithms are represented by graphical objects. Control logic is laid out by placing objects on a palate and connecting the output of one object to the input of the next object. Once completed, the object oriented diagram is compiled and checked for errors, and when all errors have been eliminated, the program can be downloaded to a controller.

67. **General**: Basic Contract definitions are included in the Conditions of the Contract.

68. **High Volume Accumulator:** Given the physical difficulty in measuring the static pressure of the outside air, the static pressure sensor is installed in a fabricated device that is made of a section of PVC piping. The pipe as multiple holes drilled in it to allow the interior of the pipe section to represent the static pressure without the effects of wind pressures. The sensor is installed in one end and the holes are drilled at all angles near the opposite end of the pipe. Both ends are capped.

69. **Historical Trend Data:** Trend data is a collection of values from a specific variable in a field bus level device such as the mixed air temperature on an air-handling unit. The collection of this data may be accomplished whenever the AHU is operating and then once every five minutes. This collected data is then stored in a database on a data collection computer. Once the data is removed from the device and placed in the database, it is considered to be Historical Trend Data.

70. **HOA:** Hand-Off-Auto

71. **HVAC:** Heating, Ventilating and Air Conditioning

72. **HZ:** Hertz, a unit of frequency. It is synonymous with cycles per second.

73. **I/O:** Input and Output

74. **IEEE:** Institute of Electrical and Electronics Engineers

75. **Inch-Pound Units:** A system of units used in the United States as contrasted with the SI system of units. See the ASHRAE Handbook of Fundamentals for a complete list of engineering units under this system of units.

76. **Indicated:** The term "indicated" refers to graphic representations, notes or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

77. **Inhibit Alarms:** To inhibit an alarm is to stop the transmission of the alarm message to the OWS. This may be done on chilled water plant during the winter or during major maintenance on a system when the alarms no longer have any real significance. Also referred to as disabled alarms.

78. **Initial Value (IV):** An initial setting for a parameter that can subsequently be changed by the operator without re-compiling and downloading the program.

79. **Install**: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

80. **Instance Number:** A unique number in the range of 0 to 4.194,302 assigned to each device in a BACnet system. A conflict in the instance number between two devices can be problematic. This is part of the BACnet addressing scheme for devices.

81. **Internetwork**: refers to the DDC control system's LAN, including all building networks, the campus network, and all associated equipment and cabling.

82. **Interstitial Space:** The space above a ceiling and below the above floor. Ductwork, piping and electrical cables are typically run in this space.

83. **ISA:** Instrumentation, System and Automation Society

84. **Key Contact**: a person designated by the Owner to closely work with the DDC System Supplier. This person may eventually administer the DDC system at the Owner's facility.

85. **Labor**: in the Bid Form, labor by the DDC System Supplier shall include all engineering, custom software programming, submittals, coordination, supervision, checkout, start-up, testing, service and maintenance, and warranty services. It will include all work, training and administrative tasks required by the specifications.

86. **Latch:** A term used in describing control logic where a state change by a binary variable causes another point in the logic to change states and remain at the new state even though the initiating variable reverts to its original state. Latching functions include a reset function that allows the latched variable to revert to its original state when the reset input is toggled.

87. **Later Personnel Training**: is to mean that one additional trainee is to be trained by special arrangement, outside of the regular schedule of training as specified.

88. **Line Programming:** Line programming based application programming tools use line code that is similar to FORTRAN, Basic or C+ programming. Master programs and subroutines are created to meet a sequence of control. The program is then compiled and downloaded to a controller.

89. **Links:** A link is a mechanism by which the system operator can change the operator workstation view from one part of the system to another part of the system or from one graphic page display to another graphic page display.

90. **Local Area Network (LAN):** means the network which connects all of the DCPs. The operator controls may also be connected to LAN. This network is usually an industry standard network such as Arcnet or Ethernet.

91. **Logic Generated Application Parameter:** An application parameter for a control process that is generated by secondary or supporting logic. Example: A proportional plus integral (PI) control loop is used to control a chilled water coil in an Air Handling Unit. The process variable is the discharge air temperature. The set point for the PI control loop is a function of the maximum terminal load from all of the terminals being supported by the AHU. The PI control loop set point is a Logic Generated Application Parameter. If in the sequence of control, a Logic Generated Application Parameter is appended with (rpt), the value of the Logic Generated Application Parameter shall be an output network variable from the control device.

92. **Lump Sum Work**: is the work that is required to be done as part of this Document. This work includes the work associated with various packages as described.

93. **Manual Control:** A concept where the operator, from the operator workstation, takes control of an end device and forces a specific position or state. From a software perspective, the value produced by the control logic is not allowed to affect the position or state of the end device. The manual mode and the desired manual position or state, are parameters that are set by the operator.

94. **Maximum Send Time Parameter:** A parameter used to ensure the periodic update of network data. If a time period equal to the value of this parameter has expired without a broadcast of the variable, are-broadcast of the current value shall be executed. See also send on delta (change of value) and minimum send time parameter definitions.

95. **Minimum Send Time Parameter:** A parameter used to control unnecessary broadcasting of data onto the network. A broadcast of an updated value shall not occur unless a time period equal to the value of this parameter has expired. The expiration of the time period does not mandate a re-broadcast. See also send on delta and maximum send time parameter definitions.

96. **Modulating:** Movement of a control device through an entire range of values proportional to an infinitely variable input value.

97. **Multiple Controller Integrated Control (MCIC):** A concept where multiple controllers with I/O are used to control a single mechanical system such as an air-handling unit. Under this concept, the mechanical system is sub-divided into a collection of processes to be controlled such as the fan start stop circuit, the fan variable speed drive, the mixed air section, the cooling coil section, etc.

98. **NC:** Normally Closed. Refers to the position of a switch or end device when the control signal is removed. Switch or device shall be closed.

99. **Network Number:** Each unique element of the system architecture is assigned a network number as part of the addressing scheme for a BACnet system. The IP layer has a network number. Each field bus has a network number.

100. **NO:** Normally Open. Refers to the position of a switch or end device when the control signal is removed. Switch or device shall be open.

101. **Owner**: Montgomery College

102. **Owner's DDC System Coordinator**: is the lead contact of the Owner for the DDC system for construction projects. This person will interface with the Owner and the DDC System Supplier.

103. **Owner's Lead Contact**: is the Owner's main contact for the DDC system project. This terminology shall be assumed to mean the same as paragraph GG (above).

104. **OWS**: Operator Workstation. With BACnet systems and operator workstation is also referred to as a BACnet OWS.

105. **P:** Proportional only control

106. **Package**: a portion of the project with specific starting and ending periods. Generally, a package will begin with a letter to the contractor (DDC System Supplier) signed by the Owner. The package will end with the Owner's beneficial occupancy of the space. Once the Owner has taken beneficial occupancy of the space, the warranty period for the work provided under that package will begin.

107. **PI:** Proportional plus integral control.

108. **PICS:** Protocol Implementation Conformance Statements.

109. **PID:** Proportional plus integral plus derivative control.

110. **Point**: defined as a hardware I/O to the DDC system. Each hardware point shall occupy a maximum of one wiring termination in a DCP, DTC, or UCP. Each UCP connection to a DCP shall be considered one hardware point.

111. **Process Control:** Process Control consists of a control loop such as PID that requires a process variable (measured by a sensor), the logic of control (PID) and an end device to be commanded. The logic of control may require numerous application parameters that may be fixed, adjustable from the OWS, or the output of secondary control logic.

112. **Process Control Sample Rate:** The time between updates of a newly calculated command to an end device.

113. **Process Variable Sample Rate:** The time between updates of measured values as measured by physical sensors.

114. **Project**: the scope of the total project includes all DDC work, which will be required for a specified period from the execution of the contract. Extensions or reductions in the project scope must be mutually agreed upon by the Owner and the appropriate contractors.

115. **Project Engineer-Future Projects**: is to mean the engineers working on future projects not included in this document.

116. **Project Site**: is the space available to the Contractor for performance of construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

117. **Provide**: The term "provide" means "to furnish and install, complete and ready for the intended use."

118. **Real Time Trend Data:** Trend data is a collection of values from a specific variable in a field bus level device such as the mixed air temperature on an air-handling unit. An operator workstation may poll for the value from the field device and immediately present the data in a graphical format for system troubleshooting. This type of trend data collection and presentation is called Real Time Trend Data. It is a temporary form of data collection used for periodic troubleshooting of a system problem. It is not used on a continuous basis, as excessive polling from a workstation is a poor steward of network bandwidth.

119. **Regulation**: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

120. **Repeater:** A physical device used to connect two segments. A repeater does not filter any message traffic. A repeater does isolate physical problems such as short circuits to a single segment and is typically required to allow the use of additional devices or additional cable length.

121. **Rolling Average:** An algorithm that eliminates spikes in a variable. Parameters required for a rolling average are the specified time period and the sample rate of the algorithm. When the rolling average variable is updated, the previously calculated rolling average value is multiplied by the time period less the sample rate and then added to the current value of the process variable times the sample rate. This sum is then divided by the time period. The result is the new rolling average value.

122. **(rpt):** An acronym indicating data to be reported for viewing at the OWS.

123. **Sample Rate Support:** The term, sample rate, refers to how often an algorithm is executed. An engineer may wish that a PID algorithm controlling the mixed air damper calculate a new command to the damper once every 25 seconds. The 25 seconds is the sample rate. Sample Rate Support refers to the ability to control the sample rate for any given algorithm.

124. **Send on Delta Parameter (Change of Value):** A parameter used to control unnecessary broadcasting of data onto the network. A broadcast of an output variable shall not occur unless the output variable has changed by an amount equal to or greater than the value of this parameter and the minimum send time has expired since the last broadcast. See also minimum send time and maximum send time parameter definitions. For binary data, the send on delta parameter is assumed to be a change of state. Logic to support the send on delta concept may be imbedded in the configurable structure of an output point or programmed as part of the logic.

125. **SI Units:** A system of units based on the metric system. See the ASHRAE Handbook of Fundamentals for a complete list of engineering units in this system.

126. **Software Point**: defined as any hardware point or point created within the system using a calculation or data manipulation.

127. **SQL:** Structured Query Language. A standard interactive and programming language for getting information from and updating a database via queries.

128. **Stand-Alone Controller:** A stand-alone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A stand-alone controller will also have data management features such as time schedules, trend data storage and alarm message generation capabilities.

129. **State Descriptors:** DDC devices work in the world of binary numbers. When a binary value is displayed at the OWS, state descriptors can be appended to the data such that the operator shall see the English words rather than the binary values. Example: 0= OFF, 1= ON or 0= STOP, 1= START.

130. **Sub-LAN**: the network wiring for connecting UCPs. There could be several sub-LANs under a DCP.

131. **Supervision**: the DDC System Supplier shall work with the DDC System Installer to obtain the final product, an operating DDC system. The DDC System Supplier shall provide sufficient supervision of these installers to ensure the work is installed without delay.

132. **Supervisory Logic:** Control logic that does not directly rely on physical inputs or physical outputs as does process control. Supervisory Logic uses data from multiple process control loops, applies defined logic to the collection of data and generates instructions to process control loops. Example: Collect the damper positions from 25

VAV controllers. Determine the highest value. When the highest value is at 50%, send a static pressure set point of 1.0 inches of water (adj) to the air handling unit controller. When the highest damper position is at 90%, send a static pressure set point of 1.5 inches of water (adj) to the air handling unit controller. Supervisory Logic may be executed in Building Controllers or Advance Application Controllers.

133. **System Messages:** A message in the event log or alarm viewer that is generated within the OWS and not from a binary indicator broadcast from a controller.

134. **TCP/IP:** Transmission Control Protocol/Internet Protocol. A basic communications protocol in a private network, either an intranet or an extranet.

135. **Testing Laboratories**: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report and interpret the results of those inspections or tests.

136. **Terminator:** An electronic component that consists of a resistive and capacitive circuit specifically designed to enhance the quality of communications on a segment.

137. **Test Instrument Certification Data:** Test instruments are used to measure analog variables in order to effect the calibration of the analog sensor. Test instruments must be periodically re-calibrated by an instrument calibration laboratory to ensure accurate measurements. Re-certification shall be every 12 months unless otherwise specified by the manufacturer of the instrument.

138. **Test Mode:** A concept where the operator from the OWS can interrupt the flow of data from a sensor to the control logic and insert a mandatory test value or test state to be used by the control logic. The test mode and the desired test value or state, are parameters that are set by the operator.

139. **Throttling Range (TR):** A term used with proportional control. It is the amount of change in the process variable that will cause the proportional loop output to change by 100%.

140. **Transmitter:** A transmitter is a device that measures a process variable such as temperature, pressure or relative humidity and generates a corresponding electrical signal such as 0 to 10 VDC or 4 to 20 milliamps for input to a controller.

141. **Trend Chart:** A trend chart is the graphical presentation of trend data. A trend chart can be associated with real time trend data or historical trend data.

142. **Trend Logs:** A trend log is a collection of samples from a specified variable that are stored within a device on the field bus. This data will be periodically sent to the data server for long term storage and reports.

143. **Trend Logging:** The process of sampling and storing periodic values from the same variable at specific time intervals. The samples are stored at the device level and periodically uploaded to the data server where they become historical trend data.

144. **Tuning Parameters, Floating Control:** For floating control, the tuning parameters shall consist of the set point, neutral zone, sample rate, bump rate, shut down value**,** start up time and start up value. The action of the floating control loop, direct or reverse shall be hard coded to meet the needs of the application.

145. **Tuning Parameters, PID Control:** For PID control, the tuning parameters shall consist of the set point, loop throttling range, sample rate, integral time constant or integral gain, and derivative time constant or derivative gain, dead zone and shut down value. The action of the PID control loop, direct or reverse shall be hard coded to meet the needs of the application.

146. **UL:** Underwriters Laboratory

147. **Unitary Control Panel" (UCP or UC):** means the application specific controllers. These panels can provide stand-alone operation. Some of these panels may be configured for use with specific equipment while others will be programmable for custom applications. Units may have universal inputs/outputs.

148. **University Points or I/O**: means that all of the points that connect to the DCP, UCP/UC, or DTC are user definable; there are no fixed inputs or outputs (digital or analog).

149. **UPS:** Uninterruptible Power Supply. A device that allows your computer to keep running for at least a short time when the primary power source is lost. A UPS contains a battery that provides power when the primary power source is lost.

150. **Validate:** A term used in concert with calibration and sequence of control performance verification. To validate is to verify that processes have been executed and the results are within defined standards.

151. **VAV:** Variable Air Volume

152. **VFD:** Variable Frequency Drive

153. **Web Server:** A software package installed on a desk top computer that provides for operation access to the Enterprise Level EMCS system from a computer on the TCP/IP network, using only a browser.

154. **Work**: all labor and equipment provided under a specific contract.

1.9 SPECIFICATION FORMAT AND CONTENT

A. Specification Format: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's 33-Division format and MASTERFORMAT numbering system. This format does not intend any organization for trade union or subcontract purposes.

B. Specification Content: This Specification uses certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1. Abbreviated Language: Language used in the Contract Documents is the abbreviated type. Implied words and meanings shall be appropriately interpreted. Singular words will be interpreted as plural and plural words interpreted as singular where applicable and/or where the context of the Contract Documents so indicates.

2. Imperative and streamlined language is used generally in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor.

1.10 DRAWING GRAPHICS AND CONTENT

A. Graphics employed on the drawings are those recognized in the construction industry. Those used in mechanical and electrical contexts are generally those recommended by ASHRAE, ASME, ASPE, ISA and IEEE. Refer any uncertainty to the Engineer for clarification before proceeding.

B. The manner in which the drawings are organized or titled does not intend any group for trade union or subcontract purposes.

1.11 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with the standard as stated. If not referenced by date, comply with that in effect as of the date of the Agreement.

C. Conflicting Requirements: Where compliance with two or more standards is required and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent will be enforced. Refer requirements that are different, but apparently equal, and any other uncertainties to the Engineer for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level indicated shall be the minimum provided. The actual installation may comply exactly with the minimum specified, or it may exceed the minimum within reasonable limits. In complying with these requirements, indicated numeric values are either minimum or maximum, as appropriate for the context. Refer uncertainties to the Engineer for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Copies of standards for the performance of a required construction activity shall be obtained directly from the publication source. These standards, along with any referenced code, are to be available at the Project Site for reference.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.

1.12 GOVERNING REGULATIONS/AUTHORITIES

A. The Contractor should contact those authorities having jurisdiction for data and clarification regarding the Contractor's responsibilities to the Work.

B. Trade Union Jurisdictions: As related to the construction activities, maintain complete current information on jurisdictional matters, regulations, and pending issues. Assign activities in a manner that will not unduly risk disputes, delays, claims and/or losses. Discuss new developments at the Project Meetings at the earliest date.

1.13 SUBMITTALS

A. Permits, Licenses, and Certificates: Submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

B. Schedule of Standards and Codes: Submit a listing of the standards and codes that will be maintained at the Project Site. Once accepted, provide a copy of this listing to each subcontractor and supplier.

1.14 GENERAL DESCRIPTION OF PROJECT WORK

A. This division of the specification covers execution of the direct digital control (DDC) system work.

B. This division of the specification is divided into six (6) parts to facilitate indexing and referencing.

C. The DDC system shall be furnished by the DDC System Supplier

D. The DDC System Supplier shall supervise the DDC system installation to ensure that the installation is completed in a workmanlike manner and to satisfy himself that all work has been installed correctly so that he can provide a complete warranty for the system.

E. In all cases where a device or equipment item is referred to in the singular, such reference shall apply to as many such items as are required to complete the installation.

F. The following paragraphs outline the work which will generally be performed by the DDC contractors under most circumstances.

G. The work covered by this specification consists of furnishing all engineering, coordination, supervision, start-up and testing services, training, necessary coordination with the owner, the contractor, equipment, accessories, and materials, and complete the installation of the DDC system in strict accordance with this specification and applicable drawings. Where the sequence of control for an equipment item or system has not been specifically addressed, the industry standard operation sequence shall be provided. If this is the case, the DDC System Supplier shall amplify or explain in detail what is being provided. The work by the DDC System Supplier generally includes the following:

1. Provide a complete DDC system as described herein. The system shall be an integrated, easy-to-operate, flexible, microprocessor-based or desktop microcomputer-based direct digital control system for control of heating, ventilating, and air conditioning, as well as space pressurization. The DDC system shall be completely factory programmed, including all color graphics and report tables, and ready for operation.

2. The proposed system shall include any software required to program the proposed controllers. This software shall reside on the PC's. connected to the network and be configured such that any remote operators console can be used to program any of this DDC systems controllers connected to the network anywhere in the system. All scheduling, alarming, trending, and graphical user interfaces shall be accomplished through the system.

3. Provide the automatic temperature control system including all sensors, actuators, end devices, display devices, stand-alone local control panels, network subsystems, all communication and application software, all power and control wiring and all computer equipment consoles required by the drawings and the specifications.

4. Provide hardware and software complete with all engineering, documentation, start-up/commissioning, calibration, testing, trouble shooting, field service, training, and warranty as described herein.

5. Provide electronic sensors for all major HVAC equipment and for other equipment as herein described.

6. Provide a complete set of submittals as described herein.

7. Provide complete start-up and testing services as herein described.

8. Provide training to the Owner as herein described.

9. Provide Owner's Manual, complete operating instructions and spare parts lists as herein described.

10. Provide a minimum two-year full service parts and labor warranty on all control components. Provide a minimum five-year full service parts and labor warranty on DCP, operator interfaces, servers, and any other interface device.

11. Provide five-year operating system upgrades.

12. Furnish the specified number and types of spare parts to maintain critical operation.

13. Provide and closely supervise the DDC system installation to ensure that the installation is completed in a workmanlike manner and to satisfy himself that all work has been installed correctly so that he can provide a complete warranty for the system.

14. Provide automatic air dampers, complete with pneumatic or electronic actuators as specified. Provide valves with valve actuators as specified.

15. Provide all unitary application-specific control panels and actuators. Coordinate with the Owner.

16. Coordinate work with the work of each and every party involved in the project.

17. Provide other work that is required for a complete and operating DDC system, which is not specifically called out.

H. Qualifications of DDC System Supplier

1. The DDC System Supplier shall have been involved with the development and the supply of similar equipment for at least five (5) years.

2. The DDC System Supplier or his representative shall have played a major role in the operation and testing of the proposed equipment type at the factory or a test facility.

3. The DDC System Supplier and his representatives shall each have a successful track record of installations using the type of equipment described herein. The proposer shall be able to submit a minimum of 10 completed projects of similar size, design, and complexity. These systems shall serve as references regarding the system and the performance of the DDC System Supplier's capability and performance.

4. The DDC System Supplier and his representative shall have in-house engineering and service personnel experienced in implementing this type of project. The engineering and service technicians assigned to the project shall have a minimum of five years of experience in systems of this type. The DDC System Supplier shall submit for approval, the resume of all personnel to be used on the project.

1.15 IMPERATIVE LANGUAGE USED GENERALLY IN THE SPECIFICATION

A. Except as otherwise indicated, the requirements expressed imperatively are to be performed by the contractor. For clarify of reading at certain locations, contracting subjective language is used to describe responsibilities, which must be fulfilled indirectly by the contractor, or when so noted, by others.

1.16 BIDDER'S INITIATIVES

A. The DDC System Suppliers must provide a bid for the system as specified. Deviations from the specification in quoting the bid prices may render the bid invalid.

B. If the DDC System Suppliers have suggestions or value engineering alternatives, the same should be listed along with the price, in the Bidder's Initiatives Supplement to the Bid Form.

1.17 DDC SYSTEM SUPPLIER'S LEAD PERSON

A. The lead person is the main Project Engineer who will be the DDC System Supplier's main contact with respect to the project. It is intended that he will not have to confer with the DDC System Supplier's branch manager on most details.

B. The lead person is expected to have several years' experience with the DDC System Supplier whom he represents.

C. The Owner will have the option to approve the lead person, whose resume shall be submitted with the proposal, or to reject him. Should the Owner reject the proposed lead person, the DDC System Supplier shall offer another lead person who meets the Owner's approval at no additional cost to the Owner.

D. During the course of the project, the Owner will have the right to request that the lead person be replaced because of failure to perform. This person will then be replaced with another lead person who meets the Owner's approval at no additional cost to the Owner.

E. "Failure to perform" would include, but not be limited to, the following:

1. Not fulfilling his lead person functions.

2. Failing to be able to act independently of the branch office on most matters.

3. Failing to respond to any and all matters on a timely basis.

4. Failing to get the DDC system operating properly.

F. Lead person primary functions shall include the following:

1. Act as primary contact person for all matters relating to project, schedule, technical matters, billing and administrative problems.

2. Attend construction meetings for the various work packages for which the DDC system supplier has a contract with the Owner.

3. Provide lead engineering for and review all technical submittals for the initial project and future work packages.

4. Prepare testing plans and procedures.

5. Prepare training agenda.

6. Attend kick-off meeting for new projects involving the DDC system.

7. Coordinate, review and approve all DDC system engineering work for conformance to specification, conformance to material standard requirements and conformance to budget requirements.

8. Prepare updated unit pricing annually and review the updated pricing with appropriate Architect/Engineer and Owner representatives, as required.

9. Coordinate work with the Architect/Engineer and Owner.

10. Review and approve all project billings.

11. Coordinate all work being performed by all Engineers and installation supervisors provided by the DDC System Supplier under this contract.

12. Coordinate new DDC system works with the existing DDC system work by coordinating with the Owner's maintenance personnel.

13. Work with the Engineer on the design of control systems for scope changes.

14. Be responsible for accurate installation of all equipment.

G. The lead person will be responsible for supervising all installation work and as such may be supported by the DDC System Supplier with additional personnel to fulfill those duties at no additional cost to the Owner.

END OF PART 1

PART 2 - GENERAL COORDINATION AND ADMINISTRATION

2.1 SCOPE OF THIS SECTION

A. This specification covers the general requirements for project coordination and administration of the DDC System project for the work related to the entire project, as well as individual packages. This part also describes the general requirements for system installation, start-up, testing, submittals, etc.

B. For various packages described in this document and all future DDC System packages, requirements for that building package shall apply. In case of two conflicting directions, the most stringent requirement shall apply.

2.2 ABBREVIATIONS AND DEFINITIONS

A. See Section 230900/Part 1, 1.7 and 1.8 for Abbreviations and Definitions respectively.

2.3 APPLICABLE STANDARDS AND PUBLICATIONS

A. The standards and publications listed hereafter form a part of this specification to the extent referenced. The publications are referred to in the text by their abbreviated designation only. Other publications, codes, and standards may also be applicable.

1. Federal Communications Commission (FCC) Rules and Regulations:

Part 15	Radio Frequency Devices (Vol. II, July 1981)
Part 68	Connection of Terminal Equipment to the Telephone Network (Vol. X, July 1977)

2. American National Standards Institute (ANSI) Publications:

C2-1987	National Electrical Safety Code
C62.41-1980	Guide to Surge Voltages in Low Voltage AC Power Circuits
C12.1-1982	Code for Electricity Metering and Correction Sheet
C57.13-1978	Instrument Transformers
ANSI/IEEE C62.45-1987	Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits
ANSI/IEEE C57.110-1986	Recommended Practices for Establishing Transformer Capability when Supplying Non-sinusoidal Load Currents
ANSI/ASHRAE	Standard 135-1995

3. American Society of Mechanical Engineers (ASME) Publications:

Fluid Meters, Their Theory and Application (6th Ed., 1971; Errata 1974)

4. Electronic Industries Association (EIA) Publications:

RS-232-C	Interface Between Data Terminal Equipment and Data\Communication Equipment Employing Serial Binary Data Interchange (Oct. 1969)

5. The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Publications:

No. 142-1991	Recommended Practice for Grounding of Industrial and Commercial Power Systems
No. 1100-1992	Powering and Grounding Sensitive Electronic Equipment
No. 587-80	Guide for Surge Voltage in Low Voltage AC Power Circuits

6. National Electrical Manufacturers Association (NEMA) Publications:

250-1979	Enclosures for Electrical Equipment Incl. Rev. 1 (1000 Volts Maximum)

7. Underwriters Laboratories (UL):

UL 1449-1987	Transient Voltage Surge Suppressors
UL 268A	Smoke Detectors for Duct Applications

8. National Fire Protection Association (NFPA)

NFPA 70	National Electric Code
NFPA 101	Life Safety Code
NFPA 92A	Recommended Practice for Smoke Control System

9. 2012 International Codes

2.4 SUBSTITUTIONS

A. It is the Owner's intent to get all common types of equipment on this project. For instance, if the DDC System Supplier decides to use a Type A unitary controller of an AHU, the Owner does not want to see both Type A or Type B controllers installed on the project over the life on similar equipment of the project.

B. The DDC System Supplier shall furnish the sensors which he submits in his technical proposal only.

C. "Approved equal", as listed behind each supplier, means as approved by the Architect and Owner. When "approved equal" is listed, the DDC System Supplier shall provide the particular product specified or a comparable item with all the specified characteristics and accessories which is manufactured by a reputable manufacturer. No device, sensor, or equipment shall be substituted without the Owner's approval. Where the particular device does not meet the required specification, the DDC System Supplier will be required to provide an "approved" device at the same cost as listed on the bid form for all lump sum work.

D. Should a sensor or equipment device become technically obsolete or unavailable or should a sensor or equipment device provide unsatisfactory service as judged by the Owner and/or the DDC System Supplier, a substitution may be made. Once the substitution is made, all of the devices installed thereafter shall be the "substitute" device.

2.5 SUBMITTALS - GENERAL

A. The DDC System Supplier shall be prepared to submit requested data or samples on all material and equipment items to be installed on the project.

B. General

1. After award of contract, all items of computer software and technical data (including technical data which relates to computer software), which are specifically identified in the specification, shall be delivered strictly in accordance with the requirements of the specification to the Architect/Engineer. The Engineer and/or Architect will review all submittals and samples of conformance with design concept of the project and the information contained in the contract documents. The Engineer's and/or Architect's review is for the convenience of the Owner in following the work and does not relieve the vendor/supplier/manufacturer of the responsibility of deviations from the requirements stated in the specification and contract documents. The Engineer's and/or Architect's review shall not be construed as a complete or detailed check of the work submitted nor shall it relieve the vendor/supplier/manufacturer of responsibility for errors of any sort in the submittals and samples or from the necessity of furnishing any work required by the contract documents which may have been omitted from the submittals. The review of a separate item shall not indicate review of the complete assembly in which it functions. Nothing in the Engineer's and/or Architect's review of submittals and samples shall be considered as authorizing (1) a departure from contract documents or the specification, or (2) additional cost to the Owner, or (3) increased time for completion of the work.

2. The Engineer and/or Architect will review submittals with reasonable promptness and will return them to the DDC System Suppliers. The proposals will be stamped as follows to indicate the appropriate action taken:

a. Reviewed.

b. Revise and resubmit.

c. Rejected.

3. Manufacturer's data sheets for material and equipment shall include model numbers, dimension drawings, operating weights, material specifications, operation and controls, wiring diagrams, performance characteristics, and service procedures, including clearance requirements for maintenance work and conformation to specified codes.

4. No part of the work shall be started in the shop or in the field until the Engineer and/or Architect has reviewed the shop drawings and samples for that respective portion of the work. Shop drawings and samples shall be submitted for review sufficiently in advance of the scheduled start of the work in the shop or in the field to allow ample time in consideration of the number and complexity of the drawings in the submittal, for the Engineer and/or Architect to make an orderly review. No extension of time will be granted to the DDC System Supplier by reason of failure to perform in this respect.

5. Each shop drawing and sample submitted for review shall be accompanied by a letter of transmittal and shall be identified by the project title, DDC System Supplier's name, and a reference to the related point of the contract documents.

6. Shop drawings shall be 11 inch by Shop drawings shall be 11 inch by 17 inch, landscape, bound on the left edge. Organize the packages by building if applicable.

7. All text based documents and product data sheets shall be 8 ½ inch by 11 inch format bound on the left edge.

8. All shop drawings in AutoCAD and PDF format shall be included on fully labeled CDs that includes a table of contents file in PDF format that provides a description of all of the files on the CD.

9. All submittal packages shall be submitted in a “D” clip binder of adequate size to comfortably fit all material enclosed.

C. Design Review Meeting. All submittal packages shall be submitted in a “D” clip binder of adequate size to comfortably fit all material enclosed

1. The selected controls contractor is required to set up a meeting with the Architect / Engineer at their office to review the design intent and submittal requirements prior to the submission of the first submittal package.

2. The GC and Mechanical contractor may attend this meeting at their discretion.

2.6 SUBMITTALS FOR PACKAGES

A. Group I Technical Data Package: The items listed in this paragraph should be provided prior to starting the installation of the DDC system:

1. System Drawings: The submittals shall include the following:

a. Operator's console equipment installation, block diagrams, and wiring diagrams.

b. DCP/DTC installation, block diagrams, and wiring diagrams.

c. DCP/DTC physical layout and schematics.

d. DCP/DTC/UCP physical layout and schedules.

e. Sensor and control wiring and installation drawings.

f. Details of connections to power sources, including grounding.

g. Details of surge protection device installations.

h. Instrumentation and control diagrams that are to be posted.

i. All the drawings shall also be supplied on a CD disc in AutoCadd format.

j. Schematics showing communication equipment such as a phone modem, etc.

2. Equipment Data: The submittals shall include complete catalog cut data for all materials to be installed including field and system equipment. The following equipment shall be submitted for prior approval in order to expedite subsequent project submittals.

   a. Operator's equipment

   b. DCP/DTC/UCP

   c. Enclosures

   d. Power supply

   e. Relays

   f. Terminal strips

   g. Field devices.

3. System Description and Analyses: The submittal shall include system descriptions and analyses used in sizing equipment required by the specification. Descriptions shall describe how the equipment will operate as a system to meet the performance of the specification. This system description will not necessarily include proprietary information but must include sufficient information for a building control system operator to learn about the system operation; it may serve as a text for the training course. The submittals shall include, but not be limited to, the following:

   a. Operator's console requirements.

      1) Communication speed and protocol description (if standard methodologies are used, refer to such standards). The DDC System Supplier, when selected will be required to provide their system protocols to the Owner under a non-disclosure agreement.

      2) DCP memory size.

      3) DCP automatic start up operations.

      4) Database update procedure.

      5) DCP expansion capability and method of implementation.

      6) Sample copies of each type of DCPs-generated report.

      7) Database entry forms.

      8) Historical data and trending methodology.

   b. Software Data: The submittals shall consist of complete descriptions of DCP and operator's console software as specified. The software data will not necessarily include proprietary information but must include sufficient information for a building control system operator to learn how to operate the DDC system; it may serve as a text for the training course. The submittals shall be organized as follows:

      1) DCP Functions

      2) DCP Operating System

      3) DCP Start-up

      4) DCP Operations

      5) DCP Applications Software

      6) DCP Communications Software

      7) DCP Commands

8) Operator's Console Operating System

9) Operator's Console Communications Software

10) DE Definition Process

11) Reports

12) Control Sequences for all DCPs, DTCs, and UCPs.

c. Certifications:

1) FCC Certifications: All specified FCC certifications shall be provided with the first submittals.

4. Specific Shop Drawing Requirements

a. System Architecture Design Diagram

1) This is a riser diagram that shall show the IP layer and all of the field bus layers.

2) It shall show each computer, printer, router, repeater, controller, and protocol translator that is connected to either the IP layer or any of the field busses.

3) This diagram shall include the existing control system that is to be integrated into the common enterprise level system.

4) Each component that is shown shall have a name that is representative of how it will be identified in the completed database and the manufacturer's name and model number.

5) The physical relationship of one component to another component shall reflect the proposed installation. Example: If AHU1 controller is the closest controller to the Building Controller on the field bus, then this device shall be shown as the first device on the riser diagram just below the Building Controller.

b. This diagram shall not include power supplies, sensors or end devices.

1) Layout Design Drawing for each control panel:

2) The layout drawing shall be to scale with all devices shown in their proposed positions.

3) All control devices shall be identified by name.

4) All terminal strips and wire channels shall be shown.

5) All control transformers shall be shown.

6) All 120 VAC receptacles shall be shown.

7) All IP connection points shall be shown.

c. Wiring Design Diagram for each control panel.

1) The control voltage wiring diagram shall clearly designate devices powered by each control transformer. If the control devices use half wave power, the diagram shall clearly show the consistent grounding of the appropriate power connection. All wire identification numbers shall be annotated on the diagram.

2) The Field Bus wiring diagram shall clearly show the use of the daisy chain wiring concept, the order in which the devices are connected to

the Field Bus, and the location of end of segment termination devices. All wire identification numbers shall be annotated on the diagram.

3) If shielded communication wiring is used, the grounding of the shield shall be shown.

4) The terminal strip wiring diagram shall identify all connections on both sides of the terminal strip. Wiring label numbers for all wiring leaving the control panel shall be annotated on the diagram.

d. Wiring Design Diagram for individual components (controllers, protocol translators, etc.): The wiring diagram for each component shall identify all I/O, power, and communication wiring and the locations on the terminal blocks to which the wires are landed. Example: Fan Status sensor is wired from terminals 5/6 on the controller to terminals 17 and 18 on the terminal strip.

e. Installation Design Detail for each I/O device.

1) A drawing of the wiring details for each sensor and/or end device.

2) For devices with multiple quantities, a standard detail may be submitted.

f. A System Flow Design Diagram for each controlled system.

1) A two dimensional cross sectional diagram showing key components such as fans, coils, dampers, valves, pump, etc.

2) Identify the locations and names of all sensors and end devices that are associated with the control system. Label the panel name and terminal numbers where the connections are landed.

3) A legend shall be provided for all symbols used.

g. Direct Digital Control System Hardware Technical Data.

1) A complete bill of materials of equipment to be used indicating quantity, manufacturer, and model number.

2) Manufacturer's description and technical data for each unique device to include performance curves, product specification sheets, and installation instructions. When a manufacturer's data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.

3) This requirement applies to:

a) Controllers

b) Transducers/Transmitters

c) Sensors

d) Actuators

e) Valves

f) Relays and Switches

g) Control Panels

h) Power Supplies

i) Batteries

j) Operator Interface Equipment

h. An Instrumentation List for each controlled system.

1) The list shall be in a table format.

2) Include name, type of device, manufacturer, model number, and product data sheet number.

i. Sequence of Control: A sequence of control for each system being controlled. Include the following as a minimum.

1) Process control sequence for each end device.

2) Supervisory logic sequence of control for each system.

3) The impact of each global application program on the sequence of control (Example: Demand Control).

4) A list of all physical inputs and outputs associated with each sequence.

5) Within the sequence of control, all application parameters that are to be user adjustable from an OWS shall be annotated with (adj) after the name of the parameter. This shall include set points, reset schedule parameters, calibration offsets, timer settings, control loop parameters such as gain, integral time constant, sample rates, differentials, etc.

6) Within the sequence of control, all calculated values that are to be viewable at the OWS shall be annotated with (rpt) after the name.

7) All points that shall be subject to manual control from an operator workstation.

8) A list of all alarm points, a description of the alarm and a description of the alarm criteria.

9) A list of all variables for which historical trending will be applied, the sample rates and any criteria used to start and stop the historical trending.

10) Binding Map

11) A list of the device to device data flow. This shall not include the flow of data from devices to the presentation system.

12) Include:

a) Description of the variable.

b) Sending device.

c) Receiving device.

j. Graphic Pages: Submit a sample graphic page for each type of page described in the specification section on graphic pages

k. Setpoint List

1) Provide a list of all setpoints for the project by sequence number

2) The list shall indicate the value of all setpoints that were gleaned from the contract documents.

3) All setpoints that will be field adjusted during the commissioning and balancing processes shall be noted.

4) All setpoints that require additional information from the Architect / Engineer shall be noted.

l. Graphical Sequence Diagrams:

1) Provide a graphical sequence diagram for every sequence

2) This diagram shall match the programming used for the sequence. One should be able to determine exactly how the sequence was programmed and all of the logic contained in the sequence. All nodes shall be labeled for clarity.

3) This diagram will be used by the College to trouble shoot issues with the system after the building has been turned over to the owner. The diagram shall be modified at the end of the project to match the as built conditions.

4) If the selected control vender uses a graphical program langue, those diagrams may be used as long as they are clear and well labeled.

m. Object, Device, and Network naming convention:

1) The college has a standing naming convention for all control objects, devices, and networks. The controls contractor shall use these naming conventions when they prepare the control submittal.

2) The naming convention standard will be made available to the controls contractor for their use.

B. Group II Technical Data Package:

1. Operation Verification Testing and Endurance Testing Data: A Test Plan and Test Procedures for the Operation Verification Test and Endurance Test shall be delivered to the Architect/Engineer for approval. The Owner reserves the right to witness any and all testing and shall be notified in advance of testing. The Test Plan shall describe in general terms the applicable tests to be performed, other pertinent information such as specialized test equipment required, and duration of Operation Verification Test. The test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of the specification. The "Test Plans" for the Operation Verification Test and Endurance Test shall be delivered to the Architect/Engineer. After receipt of written approval of the Test Plan, deliver the Operation Verification Test Procedures for approval. Written approval by the Architect/Engineer of the Operation Verification Test Procedures shall be one of the prerequisites for commencing the Operation Verification Test as specified. All the test and calibration equipment required for the Operation Verification Test shall be provided by the Contractor. The test equipment provided as part of the Central System package will be used for testing.

2. Operation and Maintenance Manuals: Copies of the draft operation and maintenance manuals, as specified for the Group III Technical Data Package, shall be delivered to the Architect/Engineer prior to beginning the Operation Verification Test for use during site testing.

3. Training Documentation: Lesson plans and training manuals for the training phases, including the type of training to be provided, with a list of reference material shall be delivered for approval.

4. Data Entry Forms: Deliver the completed data entry forms utilizing all data from the contract documents, field surveys, and all other pertinent information required for complete installation of the data base. Identify, and request from the Architect/Engineer any additional data needed to provide a complete and operational DDC system. The completed forms shall be delivered to the Architect/Engineer for review and approval at least 90 days prior to the DDC system's scheduled need date.

C. Group III Technical Data Package: The Group III Technical Data Package consists of the operation and maintenance manuals. Final copies of the manuals bound in hardback, loose-leaf binders shall be delivered to the Architect/Engineer within thirty (30) days after completing the

Endurance Test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of service representatives and of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. The tabs on the tab sheets should be either laminated plastic or of metal construction to ensure that they do not disintegrate after repeated use. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the Endurance Test shall include all modifications made during installation, checkout, and acceptance. Manuals provided shall include:

1. Functional Design Manual: Twelve (6) copies.
2. Hardware Manual: Twelve (6) copies.
3. Software Manual: Twelve (6) copies.
4. Maintenance and Calibration Manual: Twelve (6) copies.
5. Operator's Manual: Twelve (6) copies.

    a. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, specific functions and sequence of operations. A description of hardware and software functions, interfaces, and requirements shall be provided for all system operating modes.

    b. Hardware Manual: A manual describing computers, I/O equipment and sensors shall be provided, including:

        1) General description and specification.

        2) Installation and checkout procedures.

        3) Equipment electrical schematics and layout drawings. (Field and panel wiring/piping diagrams between DCP panels and sensors and between DCP panels and control devices; it does not require schematics of DCP panel internal circuit boards.)

        4) System/network overview schematic drawings and I-O wiring lists.

        5) Alignment and calibration procedures.

        6) Manufacturer's repair parts list complete with part numbers, indicating sources of supply.

    c. Software Manual: The manual shall be arranged to provide for separate sections for operator's console software including:

        1) Definitions of terms and functions.

        2) Directory of all disk files.

        3) Description of all communications protocols, including data formats, command characters, and a sample of each type of data transfer. The successful DDC System Supplier shall be required to provide the protocols to the Owner under a non-disclosure agreement.

        4) Operator Commands.

        5) System access requirements.

        6) Data entry requirements.

        7) Flow charts and source code listing for custom application programs developed for Owner.

8) Provide a mathematical description of the control algorithms.

9) Organize the manual to have separate sections for all DCP software, including: definitions of terms and functions; descriptions of algorithms for the applications programs; description of implementation of the applications programs; and description of data base structure and interface with running programs.

10) Description of all communications protocols, including data formats, command characters, and a sample of each type of data transfer.

d. Operator's Manual: The operator's manual shall provide all procedures and instructions for operation of the system, including:

1) Computers and peripherals.

2) System start-up and shutdown procedures.

3) Use of operating system, command, and applications software.

4) Recovery and restart procedures.

5) Detailed data collection procedures.

6) Reports.

e. Maintenance and Calibration Manual: The maintenance and calibration manual shall include descriptions of maintenance and, where applicable, calibration for each type of equipment or device including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components. In addition, the maintenance manual shall include the following:

1) Manufacturer's equipment parts list of all functional components of the system, control diagrams, and wiring diagrams.

2) "As-Built" interconnection wiring diagrams, or wire lists of the complete field installed system with the complete, properly identified ordering number of each system component and device.

3) Addresses and telephone numbers of suppliers of parts.

4) Emergency contact person(s) available for telephone consultation and field visit if needed.

D. Group IV Data Package

1. The DDC System Supplier shall supply all drawings, including drawing revisions after start-up, to the Owner on a CD disk in a format such as AutoCADD. These drawings shall include all manually produced drawings required in the Group I submittal.

2. Software

a. Submit a copy of all software installed on the servers and workstations.

b. Submit all licensing information for all software installed on the servers and workstations.

c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.

d. Submit all licensing information for all of the software used to execute the project.

e. All software revisions shall be as installed at the time of the system acceptance.

3. Firmware Files

a. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.

b. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.

c. Submit a copy of all application files that were created during the execution of the project.

d. Submit a copy of all graphic page files created during the execution of the project.

e. Submit a copy of all secondary graphic files such as bitmaps, jpegs, etc. that were used in the creation of the graphic pages.

2.7 CHECK-OUT PROCEDURE

A. Check-out shall be accomplished by the DDC System Supplier prior to start-up and testing with each individual package. The DDC System Supplier will be responsible to initiate the checkout procedure. The Owner shall be notified prior and, at their option, shall be present to witness.

B. Two tests will be performed: A cold test and a hot test.

1. Cold Test: In this test, the DDC System Supplier shall verify all wiring terminations prior to energizing any equipment.

2. Hot Test: In this test, each control device, the DCP, DPT, and/or UCP shall be energized. Each sensor or transmitter shall be verified to be operating and connected to the proper termination address and each control device shall be operated.

C. The DDC System Supplier shall jointly conduct the "cold" and "hot" tests. This will be demonstrated through a "Sensor/Operator Check-Off Procedure". The completed "check-off sheet" shall be turned over to the Architect/Engineer or Construction Manager as applicable prior to start-up and testing.

D. The responsible DDC System Supplier shall repair any software problems, shorts, ground faults, leaks, wiring terminations, or tubing terminations as required, and shall repair or replace any defective parts.

E. This check-out procedure shall be performed on all present and future packages.

2.8 START-UP AND TESTING

A. The DDC System Supplier shall provide start-up, testing, and adjustment of the completed DDC System. The DDC System Supplier shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all start-up and testing. Written notification of any planned start-up and testing shall be given to the Architect/Engineer and Owner at least 14 days in advance of such work, and in no case shall notice be given until after written approval of the test plans and procedures as specified has been received from the Architect/Engineer.

B. Startup Testing Plan: Submit a start up testing plan for each unique system.

1. The purpose of a startup test is to demonstrate the “completeness” of the physical tasks associated with installation and the physical performance of the components.

2. For each task on the startup test checklist, the plan shall require the technician to enter his or her initials and the date the test was completed along with any recorded data such as voltages, offsets, or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

3. Required elements of the startup testing include:

a. Measurement of voltage sources, primary and secondary.

b. Verification of proper controller power wiring.

c. Verification of component inventory when compared to the submittals.

d. Verification of labeling on components and wiring.

e. Verification of connection integrity and quality (loose strands and tight connections).

f. Verification of bus topology, grounding of shields and installation of termination devices.

g. Verification of point checkout.

1) Each I/O device is landed per the submittals and functions per the sequence of control.

2) Analog sensors are properly scaled and a value is reported

3) Binary sensors have the correct normal position and the state is correctly reported.

4) Analog outputs have the correct normal position and move full stroke when so commanded.

5) Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.

h. Documentation of analog sensor calibration (measured value, reported value and calculated offset).

i. Documentation of Loop tuning (sample rate, gain and integral time constant).

4. Submit at least four weeks prior to any scheduled start-up tests.

C. The DDC System shall be started in stages to facilitate the construction schedule. The portions tested shall be as large as practically possible. Portions of the systems to be tested shall be started, operated, and tested independently of previously accepted portions of the system (i.e., before Local Project Specific LAN communication connections are made to the Main Facility-Wide LAN which may exist and be in operation at the time). Testing provided by the DDC System Supplier shall be designed to minimize interference between new and operating systems prior to making the actual LAN connection. The tests on new or add-on systems should include simulations of shared data or functions from the existing LAN system operation.

D. Upon completion of the installation, the DDC System Supplier shall start up the system and perform all necessary testing and debugging operations. An acceptance test shall be performed in the presence of the Owner's representative and the Architect/Engineer. The acceptance test will be performed by the Owner's TAB Agency and/or commissioning agent and will cover sequence verification, sensor calibration, and point to point graphic verification. The University Building Engineer shall also be requested to be present to witness the start-up and testing. This test, as a minimum, shall include an operation/verification endurance test which verifies two weeks of completely automatic and stable system operation has occurred without an unexplained point failure or alarm. The system shall also provide comfort conditions in all spaces affected by the work.

E. Startup Testing Report.

1. Startup testing reports shall be submitted on a per system basis.

2. Startup testing reports shall be the documented results of the executed startup testing plans.

F. Performance Verification Testing Plan: Submit a verification plan for each system.

1. The purpose of a performance verification test is to ensure that the system performs in accordance with the sequence of control. For each end device that is controlled, there shall be a series of step by step cause and effect tests to verify each aspect of the

sequence of control. A sample sequence of control with corresponding performance verification test is included as Appendix B.

2. A performance verification test shall also be defined for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including but not limited to the following.

   a. Login and user settings.

   b. Graphics navigation.

   c. Trend data collection and presentation.

   d. Alarm handling, acknowledgement, and routing.

   e. Time schedule editing.

   f. Application parameter adjustment.

   g. Manual control.

   h. Report execution.

   i. Automatic backups.

   j. Web Client access.

3. Submit at least 4 weeks prior to the scheduled execution of the test.

G. Upon receipt of a detailed punch list from the Architect/Engineer, an installation inspection report shall be prepared by the DDC System Supplier showing, by system, each outstanding item on the punch list. After all items appearing on the installation inspection report are completed, a second written request for system approval shall be made to the Architect/Engineer. As each or all items are approved, an appropriate notation shall be entered at the time of joint inspection on the system report, with countersignature of the Architect/Engineer and date. A copy of this report shall be made for the Owner.

H. Where it is required for the DDC System Supplier to modify, alter, add or remove hardware or software programs to the system, or related accessories for the purpose of eliminating punch list items, off-line operation and testing to implement these items shall be performed as required until such time acceptable performance of the system has been established at no additional cost to the Contract.

I. Problems which occur within approved hardware, or software, shall be corrected in an appropriate fashion under warranty. Any such occurrence shall not void previous approval; however, the DDC System Supplier shall be responsible to attend to and remedy such items within the warranty period. The DDC System Supplier shall maintain appropriate logs, schedules, and reports to reflect these items and their redress.

2.9 TRAINING FOR OWNER'S PERSONNEL

A. General: Conduct training courses for designated personnel in the maintenance and operation of the DDC system as specified. The training shall be oriented to the specific system being installed under this contract. Training manuals shall be provided for each trainee with three (3) additional copies provided for archival at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The room for training will be provided by the Owner. The audio/visual equipment will be provided by this Contractor. The DDC System Supplier shall communicate his requirements for this equipment to the Owner five (5) working days before the date when the equipment is needed. The DDC System Supplier shall be responsible for all other training material and supplies. Where portions of the course material are presented by audio/visuals, copies of those audio/visuals shall be delivered to the Architect/Engineer either as a part of the printed training manuals or on the same media as that used during the training sessions, in the same quantity as specified for training manuals. A training day is defined as eight (8) hours of classroom instruction, including two

15-minute breaks and excluding lunchtime, Monday through Friday, during the normal first shift in effect at the training facility. For guidance in planning the required instruction, assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. Notification of any planned training shall be given to the Architect/Engineer at least thirty (30) days prior to the training. If off-site training is required, the Owner will take care of travel and lodging arrangements. The Owner may videotape all training sessions.

B. Operator's Training I: The first course shall be taught at the project site for a period of six (6) consecutive training weekdays during the field testing activity. The Contractor shall assume that a minimum of two (2) training sessions with five (5) people in each will be required. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include:

1. General system architecture.
2. Functional operation of the system.
3. Operator commands.
4. Control sequence programming.
5. Data base entry.
6. Reports and logs.
7. Diagnostics.

C. Operator's Training II: The second course shall be taught while the Endurance Test is in progress for a total of sixteen (16) hours of instruction per student, in time blocks of four (4) hours. The DDC System Supplier shall assume that six training sessions with two (2) people in each will be required. The schedule of instruction shall allow for each student to receive individual instruction for a four-hour period in the morning (or afternoon) of the same weekday for two (2) consecutive weeks. The Contractor shall schedule his activities during this period so that the specified amount of time will be available during the Endurance Test for instructing the students. The course shall consist of "hands-on" training under the constant monitoring of the instructor. The instructor shall be responsible for advising the Owner about the appropriate password to be issued to the student commensurate with each student's acquired skills at the beginning of each of these individual training sessions. Upon completion of this course, the students should be fully proficient in the operation of all system operations. The training instructor shall prepare a written report describing the skill level of each student at the end of this course and supply three (3) copies to the Architect/Engineer within seven (7) days of completion of the training.

D. Maintenance Personnel Training: The maintenance course shall be taught at the project site after completion of the Endurance Test for a period of six (6) training days. The Contractor shall assume that three (3) training sessions of eight (8) people will be required. The training shall include:

1. Physical layout of each piece of hardware.
2. Troubleshooting and diagnostics procedures.
3. Repair instructions.
4. Preventive maintenance procedures and schedules.
5. Calibration procedures.

E. Executive Training for Planners/Supervisors: This training course shall be taught after completion of the Performance Testing. The requirements of this training course are to provide necessary background to the engineering planners/supervisors about the operation of the DDC system. This training shall consist of two 4-hour classes. Before commencement of this training, at least fourteen (14) days advance notice should be given to the Architect/Engineer. The Owner will

stipulate the number of people that will attend this training course. The training shall include, but not be limited to, the following:

1. Brief description of system architecture.
2. Functional operation of the system.
3. Summary of operator commands.
4. Overview of control sequence programming.
5. Organization of the database.
6. Reports and logs that are available.
7. Overview of the system diagnostics capabilities.
8. Transport of summary level data about building operation energy use and maintenance, for use with commercial spreadsheets and word processing programs.
9. Training for the remote monitoring of the DDC system.
10. Description of the database for detailed (every minute) data collection and method for access.

F. Training/Review Session: Conduct one 8-hour training or review session at the project site, no less than thirty (30) days and no more than sixty (60) days after the acceptance test. The purpose of this session is to allow the trainees to have their questions, which they may have had after system operation, answered. Further training/review sessions may be obtained by the Owner based on unit prices listed in the bid documents.

2.10 TRAINING FOR "ADD-ON"

A. The DDC System Supplier shall provide instructions for all new add-on systems or packages as they come on-line. Each instruction session shall include one 8-hour classroom period. For guidance in planning, it is assumed that all of the students attending these classes are familiar with the existing DDC System and its capabilities and/or have attended previous training classes.

B. The purpose of the instruction is to familiarize the building operators with the new equipment being installed under this contract.

C. The DDC System Supplier shall provide a minimum of ten (10) manuals for instruction in addition to the material required for the trainees. The Owner has stipulated that the maximum number of personnel who will attend each session is six (6). The instruction session will be scheduled with the Owner. The notice for starting the training shall be given to the Architect/Engineer. This notice shall not be less than fourteen (14) days in advance of training.

D. The 8-hour classroom training period will include the following:

1. General description of new equipment installed.
2. A listing and description of each new point and its "name".
3. A general description of the sequence of operation for each new piece of equipment including normal setpoints and all normal and emergency functions. This should include a review of appropriate control drawings, etc.
4. Maintenance training for all "new types" of equipment installed in the facility as a part of the contract.

2.11 WARRANTY TO BE PROVIDED AS PART OF EVERY PACKAGE

A. All devices and components shall be warranted for a period of two (2) years following the date of acceptance of the Performance Verification Test. All system management consoles, DCP, UCPS and software shall be warranted and upgraded to the latest operating system version for a period of five (5) years following the date of acceptance of the Performance Verification Test. This

warranty shall include labor and material. Any defects arising during this warranty period shall be corrected without cost to the Owner. During the warranty period, the Contractor's service personnel shall be available to be physically present at the facility within twenty-four (24) hours for emergency repairs. The Contractor shall consider the possibility of allowing Owner's trained maintenance personnel to affect repairs of extremely critical nature, even before the service representative arrives at the site. For this purpose, a stock of necessary spare parts shall be maintained at the facility. If the Owner's stock of spare parts is used for in-warranty repair, such stock shall be replenished within ten (10) working days.

B. Programmed Preventive Maintenance. The DDC system supplier will perform programmed preventive maintenance. For this purpose, complete requirements for this activity shall be provided, prior to final payment.

C. Preventive Maintenance. The DDC system supplier will perform all required programmed preventative maintenance. Provide complete instructions and the requirements for this activity. Also provide a schedule list for this activity. Each schedule shall list the equipment name, location, and appropriate preventive maintenance functions to be performed during that inspection. The work performed includes, but is not limited to, the following:

1. Check calibration, recalibrate if needed, instrumentation sensors for air flow, liquid flow, pressure, humidity, temperature, and transmitters. Written records shall be kept indicating the performance of such calibrations along with pertinent data. The calibration and operational ranges for all sensors shall be kept with the written records.

2. Check the operation of dampers and damper actuators to assure no seizing or lock-up has occurred. Written records shall be kept indicating the performance of such calibrations along with pertinent data.

3. Check the overall system field operation by performing an all-points review (by hard copy or by documenting all point CRT inquiries). Verifying that all monitoring and command points are valid and active.

4. Check alarming capabilities and system response by initiating alarms and observing the time duration of the responses. Written records shall be kept indicating the performance of such exercises.

D. Upgrades and Maintenance: standard software upgrades shall be included in the price for a period of five (5) years. Training required for software within this period shall be free of charge. Upgrades after this would be at additional cost and at the Owner's discretion. If software is changed due to error (or bugs), such modifications to the software shall be at no cost to the Owner for a period of ten (10) years.

E. Failure by the DDC System Supplier to provide warranty work within one (1) day shall render his conduct as negligent, in which case the Owner shall be entitled to proceed with such work at his discretion and back charge the DDC System Supplier at cost plus 10 percent for expenses incurred.

F. The DDC system supplier shall maintain for the Owner a complete accounting of all systems and components that are under warranty, including a listing of all systems under extended warranty. The listings shall be submitted to the Owner on a quarterly basis.

G. During the first two years of operation, make any recommendations for system modification, in writing, to the Owner and Architect/Engineer. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Architect/Engineer. Any modifications made to the system shall be incorporated into the operation and maintenance manuals, as-built drawings, and other documentation affected.

H. The DDC System Supplier shall provide all custom software updates for control sequence modifications and verify operation in the system. These updates shall be accomplished in a timely manner, shall be fully coordinated with DDC System operators, and shall be incorporated into the operation and maintenance manuals, and software documentation.

2.12 THREE (3) YEAR EXTENDED MAINTENANCE PROGRAM

A. The DDC System Supplier shall provide guaranteed prices for service contract to maintain the system as described above. This price shall be applicable for three (3) years after the warranty expires, and not during the warranty period. Prices shall be submitted for service contractor on a per year basis for the three (3) years. The acceptance of the service contract shall be at the sole discretion of the Owner.

B. This work shall include all parts and services required and equipment necessary to maintain the entire DDC System in an operational state as specified and shall be provided for a period of three years after the initial warranties expire. Impacts on facility operations shall be minimized when performing scheduled adjustments or other nonscheduled work.

C. The adjustment and repair of the DDC System includes all computer equipment, software updates, transmission equipment, DCP's, and all new sensors and control devices. Responsibility shall include all equipment furnished as a part of the DDC system. The manufacturer's required adjustments and all other work necessary shall be provided.

D. A minimum of two service personnel shall be qualified to accomplish all work promptly and satisfactorily with the DDC System Supplier's service organization. The Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel. In addition, when a change in personnel is made, the outgoing or remaining representative is expected to orient the "new" service representative to the system and to the building. The DDC System Supplier's service personnel are expected to be familiar with the facility, with the location of the DDC System Devices, and with the locations of the equipment served by these devices without being accompanied by the Owner's personnel.

E. The work shall include two minor inspections at six-month intervals or less, two major inspections (offset equally between the minor inspections to effect quarterly inspection of alternating magnitude), and all work required as specified. Preferably, major inspections shall be scheduled in June and December.

1. Minor inspections shall include:

   a. Visual checks and operational tests of all equipment.

   b. Check the overall system field operation by performing an all-points review (by hard copy or by documenting all point CRT inquiries). Verify that all monitoring and command points are valid and active.

   c. Inventory and replenish the Owner's stock of spare parts that the contractor has used in maintenance and repair of the system.

   d. Submit report to the Owner detailing exact items or tasks which were accomplished.

2. Major inspections shall include all work described under "Minor Inspections", plus the following work:

   a. Perform diagnostics on all equipment.

   b. Resolve any previous outstanding problems.

   c. Submit report to the Owner detailing exact items or tasks which were accomplished.

F. In addition to periodic inspections, the DDC System Supplier shall perform in accordance with a program of standardized preventative maintenance as applicable to the Owner's equipment. Maintenance shall be performed a minimum of four times per year and shall coincide with the major and minor inspections. During this activity, the DDC equipment functions shall continue. Each schedule shall list the equipment name, location, and appropriate preventive maintenance functions to be performed during that inspection. The work performed shall include, but not be limited to, the following:

1. Clean all system equipment including CPU, disk memory, RGB color CRT, monochrome CRT, printer, intercom, DCP units, and printed circuit boards.

G. All minor and major inspections and all preventative maintenance work shall be performed during regular working hours, Monday through Friday, excluding legal holidays and as agreed to by the Owner.

H. Performance of scheduled adjustments and repair shall verify operation of the DDC System as demonstrated by the applicable portions of the Operation Verification Test.

I. Refer to Warranty paragraph for requirements on emergency service.

J. The DDC System Supplier shall keep records and logs of each task, and shall organize cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial analog span and zero calibration values and all digital points. Complete logs shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the DDC System.

K. Each maintenance service call request shall be recorded by the DDC System Supplier, as received. The record shall include the serial number identifying the component involved; its location, date, and time the call was received; nature of trouble; names of the service personnel assigned to the task; instructions describing what has to be done; the amount and nature of the materials to be used; the time and date work started; and the time and date of completion. The Owner shall receive a record of the work performed within five (5) days after work is accomplished.

L. The DDC System Supplier shall make available at no additional cost standard software upgrades which will make available corrections and improvements in software which the Owner has already purchased as a part of this contract. This shall be done for the first five (5) years of the warranty. If the Owner chooses to have a service and maintenance contract, then the DDC System Supplier shall provide and install all software upgrades at no cost, as long as the service and maintenance contract remains in effect.

M. The DDC System Supplier shall provide all replacement hardware for three years after the warranty expires. Replacement hardware shall be purchased at the agreed upon prices given in the bid form.

N. Failure by the DDC System Supplier to provide (start and complete) scheduled maintenance work within 30 days of the established service schedule dates shall render his conduct as neglect, in which case the Owner shall be entitled to proceed with such work at his discretion and back charge the DDC System Supplier at a cost plus 10 percent for expenses incurred. Expenses shall include both material and labor.

2.13 SPARE PARTS

A. The DDC System Supplier shall provide, if directed by the Owner, spare parts. The DDC system supplier will be compensated in accordance with the price identified on the Bid Form, Document 00400. These spare parts are to be used for emergency service work and for preventative maintenance work and shall be restocked within ten (10) days of use. The entire stock of parts shall be provided when the first equipment is started up and shall be available intact at the end of the warranty period.

1. Provide a recommended spare parts list to the Owner for review.

2.14 INSTALLATION FOR ALL PACKAGES

A. Installation of Equipment

1. This paragraph describes requirements for installation of equipment on this project.

2. All system components and appurtenances shall be installed in accordance with the component manufacturer's and the DDC System Supplier's instructions. All necessary interconnections, services, and adjustments required for a complete and operable system

shall be provided. All electrical work and devices shall comply with the National Electric Code and the requirements of the Montgomery County, Maryland and all other applicable codes, and shall be installed by licensed journeyman electricians. Instrumentation and communications grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

3. All equipment shall be installed as required for an operational DDC system. In addition, the following additional precautions shall be followed and equipment shall be provided as required:

   a. All room thermostats and humidistats shall be mounted 48”-54” above the finished floor except in corridors, stairways and toilet rooms where they shall be mounted at 7'-0" above the finished floor. Refer to drawings for exemptions.

   b. RTD assemblies shall be readily accessible and installed in a manner to allow easy replacement.

   c. All RTDs installed in liquids shall be installed in stainless steel thermowalls.

   d. RTDs used for space temperature sensing shall include housing suitable for wall mounting. The housing shall also shield the sensor from sources of radiation.

   e. RTDs used for OA sensing shall have an aspirated radiation shield. The installation of OA sensors shall not be within the thermal boundary layer of the building, away from all building and automobile exhausts and shall not be mounted on concrete surfaces or on the roof.

   f. OA temperature and humidity transmitter shall be provided for, as indicated on the drawings. The preferred location is on the northward facing side of a building or on a louver mullion to an air handling unit which is scheduled to operate continuously.

   g. Averaging sensors in mixed air plenums should be installed across possible stratified air paths to insure a true average temperature.

   h. Pipe temperature sensors shall be located at least ten (10) pipe diameters downstream of converging (mixing) pipe flows.

   i. Temperature switches shall be installed in a manner similar to RTDs. Temperature switches shall be adjusted to the proper setpoint and shall be verified by calibration.

   j. Relative humidity sensors shall have air guards when in-stalled in air flows of more than 50 feet per minute across the sensor element.

   k. Pressure sensors (all types) installed on liquid lines shall have drains. Pressure sensors installed on steam lines shall have drains and siphons or drains and condensate chambers. All pressure sensors shall have 3-way valve manifolds for isolation, venting, by-passing and taps for calibration. Pressure sensors shall be verified by calibration. Differential pressure sensors shall have nulling valves.

   l. Pressure switches and differential pressure switches shall be adjusted to the proper setpoint, and shall be verified by calibration. Pressure switches shall be mounted higher than the process connection.

   m. All flowmeters shall be installed in accordance with ASME "Fluid Meters, Their Theory and Application" and other applicable industry standards. Do not install obstructions, such as temperature wells, in flowmeter "flow tubes".

   n. Flow switches shall be installed in such a manner as to minimize any disturbance in the flow of fluid while maintaining reliable operation of the switch.

o. Potential and current transformers shall be installed in approved electrical enclosures.

p. Watthour and demand meters shall be installed in approved electrical enclosures, in motor starter enclosures or in electrical switchgear enclosures.

q. Position sensing potentiometers shall be selected and in- stalled with type and mounting suited for the application to provide reliable operation.

r. End (Limit) Switches shall be selected and installed with type and mounting suited for the application to provide reliable switch operation.

s. Relays and contactors shall be installed in approved electrical enclosures, apparatus control panels, DCP panels, DTC panels, or in starter enclosures.

t. Electric solenoid operated pneumatic (EP) valves shall be installed in approved electrical enclosures or in apparatus control panels.

u. Pneumatic receiver/controllers shall be installed in apparatus control panels.

v. Current to pneumatic (I/P) transducers shall be installed in apparatus control panels, DCP panels or in DTC panels.

w. All temperature, humidity, and flow sensing transmitters and switches located in ductwork shall be installed in locations where the devices can be easily removed for routine maintenance and cleaning. This is particularly important for devices located in return air, exhaust air, and unfiltered air ductwork.

x. All wind speed and wind direction sensing devices shall be installed in a location as directed by the Architect.

4. All apparatus control panels, DCP panels and DTC panels shall be installed with the bottom 4 feet above the adjacent floor surface using an adjacent wall surface or using legs for free standing applications. All free-standing outdoor enclosures using legs shall be secured rigidly to the supporting surface to minimize vibrations from winds.

5. All penetrations in apparatus control panels and DTC panels located outdoors shall be from the bottom and shall be sealed to preclude entry of water using a silicone rubber sealant.

6. The electrical portion of the DDC system shall be installed according to the following provisions:

a. Designated circuit breakers shall be provided in various electrical distribution panel boards for powering the DDC system.

b. The DDC System Installer shall provide all power wiring required for the various apparatus control panels and DDC panels (UCPs) and sensors from these circuit breakers.

c. The DDC System Installer shall provide supplemental branch circuitry and short circuit protection including panel boards as required for proper power distribution, protection and operation of his system and equipment.

d. All wiring, conduits, additionally panel boards, etc., required to provide power for the individual DDC equipment items shall comply with the National Electrical Code (NEC), the requirements of Montgomery County, Maryland, and other applicable codes.

e. All other electrical wiring shall comply with the National Electric Code, the requirements of the Montgomery County, MD, and other applicable requirements and shall be installed by licensed journeyman electricians.

f. All peer-to-peer connections to the DDC system and the peer-to-peer network wiring and conduit shall be installed in locations identified by the DDC System Supplier in conjunction with the Architect/Engineer.

g. All DCPs, DTCs, and UCs, for the steam meters, shall be powered by normal/emergency power circuits.

h. All wiring shall be properly color-coded or identified (using terminal numbers) or both at the termination point in the DCP and DTC panels so that wiring between the panel and the sensing/control device can be easily identified.

7. All control wire and power wiring shall be provided by the DDC System Supplier. All wiring shall be installed in watertight EMT conduit with compression fittings. All copper and fiber network wiring shall be installed in watertight EMT conduit.

a. AI, BI, AO and low voltage BO wires shall be routed uniformly in a singular bundle or through a single conduit.

b. Singular or multiple 120 volt BO wires shall be routed uniformly in a singular bundle or through a single conduit. High voltage (120 volt) BO wiring shall not be installed in the same bundle or conduit as AI, BI, or AO wiring unless otherwise specified.

c. Network wiring in exposed areas shall be installed in a conduit with no other wiring.

d. All conduit shall be EMT to within 3 feet of the device. Within 3 feet, flexible conduit may be employed. All conduit shall be supported from the building structure and should not lay on the ceiling.

e. All wiring and conduit shall be run either parallel or perpendicular to walls constructed in the area served. All takeoffs or junctions shall be made at 90 degree angles.

f. Pull strings shall be provided in all conduits for the future addition of wires.

g. Provide wire identification tags (using terminal numbers) in all DCP's and DTC's panels designating terminal connection points so that wiring between the panel and the sensing/control device can be easily identified. Tab 2 shows the Owner's approved scheme for panel and equipment identification.

h. All wiring in mechanical rooms shall be in conduit.

i. Low voltage and analog wiring shall be a minimum of 18 gauge twisted shielded pair.

j. 120 volt wiring shall be a minimum of 16 gauge twisted pair for relays or status wiring.

k. Communication wiring shall be a minimum of 22 gauge twisted low capacity.

8. The requirements concerning wire and conduit installation may also be found elsewhere in the specification and drawings.

9. All instrument air lines shall be run concealed in the building construction in all finished spaces. Air lines exposed in unfinished spaces shall be run in a neat and workmanlike manner in metal raceways or conduit, or shall run exposed in hard copper tubing. Provide shut-off valve for branch isolation. All pneumatic tube material shall be suitable and approved for the service in Montgomery County, Maryland.

a. All concealed accessible instrument air lines shall be run in approved polyethylene tubing. All tubing shall conform to the requirements of the Montgomery County, Maryland.

b. All concealed inaccessible tubing shall be run in hard or soft copper tubing or in conduit.

c. Where required, all conduit shall be rigid electromechanical tubing to within 3 feet of the device. All conduits shall be supported from the building structure and should not lie on the ceiling.

d. All pneumatic tubing run without conduit shall run in bundles which are attached together using nylon ties at 3-foot intervals. Home runs of individual pneumatic tubes when bundled are available is unacceptable. All individual and bundled pneumatic tubes shall be run tight to the building structure or wall and shall be attached to the same at 3-foot intervals. Laying tubing on the ceiling is not acceptable.

e. All pneumatic tube and conduit shall run either parallel or perpendicular to walls constructed in the areas served. All takeoffs and tees from the bundles shall be made at 90 degree angles.

f. All instrument air lines installed in hot unoccupied spaces such as electrical vaults, steam tunnels, mechanical rooms with ventilation cooling only (no mechanical refrigeration), building attics and penthouses shall be run in hard or soft copper tubing. If the system is installed with polyethylene tubing each tubing termination or joint shall be provided with a metal clamping device such as a spring clamp in addition to the standard barbed fittings.

g. All instrument air mains and lines between the various system isolation valves and the room thermostats or controlling devices shall be tested.

h. All instrument air tubing between the instrument air supply (main) and the "main" air connections to control devices or control panels shall be tested for leakage. Instrument air piping upstream of pressure reducing valves shall be tested at 150 psig. All instrument air piping downstream of pressure reducing valves shall be tested at 50 psig. For all new work on the project (for projects up to 10,000 square feet work area) the test shall be completed at one time. For projects over 10,000 square feet, the project area may be broken into 10,000 square-foot increments to facilitate the construction schedule. Generally, the test shall include plugging all main air connections to terminal devices. Attach one 5-gallon portable pneumatic tank to the system for each 2,000 square feet being tested. Each tank shall be pressurized to 10 psig greater than the system test pressure. Pressurize the system, then bleed off excess tank pressure. The system shall pass the test if the pressure does not drop more than 5 psig in 24 hours.

10. All junction boxes and pull stations in the DDC conduit system shall be identified.

B. Installation - Software

1. Load all software as specified and required for an operational DDC system, including data bases, operational parameters, and all specified programs. Upon successful completion of the Endurance Test, provide two spare copies on CD ROM of source (excluding the general purpose operating system and utility programs furnished by the computer manufacturers) and object modules for all accepted software including diagnostics. Two sets of software, on media usable with the portable tester, containing all DCP software and diagnostics shall be provided.

2.15 WIRING PRODUCTS

A. The following wiring products shall be provided as required to suit project by the Controls Contractor. Wiring types provided shall be indicated on the shop drawings.

B. Wiring products shall be the product of ALFA Wire Corporation, Beldon Wire and Cable, or approved equivalent. ALFA Product numbers are provided to establish wire type, size, and materials of construction.

C. Non-plenum cable shall have passed the UL VW-1 flame test and shall have a PVC jacket which is approved for use in Montgomery County.

1. Type "A" cable shall be 18 AWG copper minimum, shielded, with 2 conductors, 300 volt insulation, and an approved outer jacket suitable for non-plenum use, UL 2092. Type "A" cable shall be used for AI and AO functions. Type "A" cable shall be ALFA Wire Corporation Number 2422C.

2. Type "B" cable shall be 18 AWG copper minimum, unshielded, with 2 conductors, 300 volt insulation, and an approved outer jacket suitable for non-plenum use, UL 2509. Type "B" cable shall be used for low voltage BI and BO functions. Type "B" cables shall be ALFA Wire Corporation Number 1897C.

3. Type "C" cable shall be 14 AWG copper minimum with two single stranded conductors and 600 volt THHN insulation. Insulation colors shall be red and black. Type "C" cable shall be used for 120 volt BO functions. Type "B" cable shall be ALFA Wire Corporation Number 1859/19.

4. Type "D" cable shall be 18 AWG copper minimum, shielded, with 3 conductors, 300 volt insulation, and an approved outer jacket suitable for non-plenum use, UL 2093. Type "D" cable shall be used for AI and AO functions and for LAN and UCP-LAN communication functions. Type "D" cable shall be ALFA Wire Corporation Number 2423C.

5. Type "E" cable shall be 18 AWG copper minimum, shielded, with 4 conductors, 300 volt insulation, and an approved outer jacket suitable for non-plenum use, UL 2094. Type "E" cable shall be used for AO functions requiring power. Type "E" cable shall be ALFA Wire Corporation Number 2424C.

6. Type "F" cable shall be RG62A/U coaxial cable with an approved outer jacket. Type "F" cable shall be used for EAN communication functions. Type "F" cable shall be ALFA Wire Corporation Number 9062AC.

7. Type "G" cable shall be 18 AWG copper minimum, shielded, with 6 conductors, 300 volt insulation, and an approved outer jacket suitable for non-plenum use, UL2464. Type "G" cable shall be used for AI and AO functions and for communications between UCPs and UCP thermostats. Type "G" cable shall be ALFA Wire Corporation Number 6063C.

8. Type "H" cable shall be 18 AWG copper minimum, unshielded, with 4 conductors, 300 volt insulation, and an approved outer jacket suitable for non-plenum use, UL 2509. Type "H" cable shall be used for low voltage BI and BO functions. Type "H" cable shall be ALFA Wire Corporation Number 1898/4C.

D. Plenum cable shall be UL listed, Class 2 power limited circuit cable, type CL2P, for plenum applications without conduit, shall have passed the UL VW-1 flame test and the Steiner Tunnel Test for low smoke and flame generation, and shall have an FEP teflon jacket which is approved by Montgomery County.

1. Type "AP" cable shall be 16 AWG copper minimum, shielded, with 2 conductors, 300 volt insulation, and an approved outer jacket suitable for plenum use, NEC 725-2(b), UL subject 13. Type "AP" cable shall be used for AI and AO functions. Type "AP" cable shall be ALFA Wire Corporation Number 58133.

2. Type "BP" cable shall be 16 AWG copper minimum, unshielded as available, with 2 conductors, 300 volt insulation, and an approved outer jacket suitable for plenum use, NEC 725-2(b), UL subject 13. Type "BP" cable shall be used for low voltage BI and BO functions. Type "BP" cable shall be ALFA Wire Corporation Number 58131.

3. Type "CP" cable is not permitted. All 120 volt BO functions must use Type "C" cable and conduit.

4. Type "DP" cable shall be 16 AWG copper minimum, shielded, with 3 conductors, 300 volt insulation, and an approved outer jacket suitable for plenum use, NEC 725-2(b), UL subject 13. Type "DP" cable shall be used for AI and AO functions and for UCP-LAN communication functions. Type "DP" cable shall be ALFA Wire Corporation Number 58133. Use of Type "DP" cable for LAN communication functions shall not be permitted; use Type "D" cable and conduit.

5. Type "EP" cable shall be 16 AWG copper minimum ,shielded, with 4 conductors, 300 volt insulation, and an approved outer jacket suitable for plenum use, NEC 725-2(b), UL Subject 13. Type "EP" cable shall be used for AO functions requiring power. Type "EP" cable shall be ALFA Wire Corporation Number 58134.

6. Type "FP" cable is not permitted. EAN communication functions must use Type "F" cable and conduit.

7. Type "GP" cable shall be 16 AWG copper minimum ,shielded, with 6 conductors, 300 volt insulation, and an approved outer jacket suitable for plenum use, NEC 725-2(b), UL Subject 13. Type "GP" cable shall be used for AI and AO functions and for communications between UCPs and UCP thermostats. Type "GP" cable shall be ALFA Wire Corporation Number 58136.

8. Type "HP" cable shall be 16 AWG copper minimum, unshielded as available, with 4 conductors, 300 volt insulation, and an approved outer jacket suitable for plenum use, NEC 725-2(b), UL Subject 13. Type "HP" cable shall be used for low voltage BI and BO functions. Type "HP" cable shall be ALFA Wire Corporation Number 58134.

E. When multiple runs of single conductor cables are employed the wiring shall be color coded in accordance with the Control Contractor's Standard for this facility.

F. Wiring shall be UL listed and labeled for specific use. The approved outer jackets shall meet the approval of Montgomery County for the specific application.

G. Wiring for photoelectric and ionization type smoke detectors shall be provided in flexible metallic tubing to facilitate removal and cleaning of the detectors.

H. Wiring for vibrating equipment including but not limited to fans, pumps, chillers, and boilers shall be provided in flexible metallic tubing.

2.16 PNEUMATIC TUBING PRODUCTS

A. The following pneumatic tubing products shall be provided by the Controls Contractor.

B. Non-metallic instrument air lines shall be an approved polyethylene tubing conforming to ASTM Specification D-1248, Type I, Class A, Category 4, Grade E5. The tubing shall be suitable for a working pressure of 150 psig at 73°F ambient. Tubing shall be 1/4 inch O.D. and 0.170 inch I.D.; minimum bend radius shall be 1 inch. Tubing shall be Parker Series E43, Dekoron F.R., or approved equal. Tubing shall conform to the requirements of the Montgomery County.

C. Main instrument air lines shall be Type "L" hard or soft copper conforming to ASTM B-88 with soldered 50-50 tin lead solder using non-acid, non-corrosive flux. Fittings shall be cast brass or wrought copper sweat type conforming to ASTM B-75. Instrument air mains on individual floors shall be minimum 1/2" O.D. Instrument air risers shall be minimum 7/8" O.D. Connections to risers shall be provided with ball valves for isolation.

2.17 CONDUIT PRODUCTS

A. The following conduit products shall be provided by the Controls Contractor.

B. Conduits shall be light wall electrical metallic conduits selected for 40 percent fill unless otherwise noted.

C. The conduit system shall be provided complete with connectors, adapters, pull stations and radius elbows as required.

D. EAN wiring shall be installed in conduits employing long radius elbows; 90° bends shall not be permitted.

E. Refer to Division 26 for requirements concerning conduit products.

2.18 OWNERSHIP OF PROPRIETARY MATERIAL

A. The Owner shall retain all rights to software for this project.

B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:

1. Server and Workstation software
2. Application Programming Tools
3. Configuration Tools
4. Addressing Tools
5. Application Files
6. Configuration Files
7. Graphic Files
8. Report Files
9. Graphic Symbol Libraries
10. All Documentation.

END OF PART 2

PART 3 - SYSTEM HARDWARE REQUIREMENTS

3.1 GENERAL

A. This document defines the minimum hardware and performance requirements for a computer-based DDC system.

B. System Requirements

1. Provide all equipment, accessories, wiring and instrument piping required for a complete and functioning DDC system.

a. All materials and equipment used shall be standard components, regularly manufactured for this system and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.

b. All embedded conduit shall be rigid conduit.

c. The DDC system shall be of a fully modular architecture permitting expansion by adding computer memory, application software, operator peripherals and field hardware.

2. Application Requirements

a. The DDC system shall meet the performance requirements of the following applications:

1) Heating, Ventilating and Air Conditioning Control

2) Air Handling Units

3) Terminal Units

4) Primary Equipment

5) Energy Management Plan

6) Historical Data Collection

7) Monitoring of critical events

8) Mass Flow Totalization

9) Record all Information required to achieve the LEED Measurement and Verification credit.

3.2 SYSTEM DESCRIPTION

A. Proposed system shall be UL listed and approved.

B. General: The Contractor shall configure the DDC system as described herein. All computing devices, as defined in FCC Rules and Regulations, Part 15, shall be certified to comply with the requirements for Class A computing devices and labeled as set forth in FCC Rules and Regulations, Part 15.

C. The system shall provide operator interaction and dynamic process manipulation, including overall system supervision, coordination, and control. Sensed data shall be obtained by DCPs which are located near the source of the data to be collected. DCPs shall manage all control functions within their Data Environment (DE) as specified.

D. The operator's console shall have the capability to communicate with the DCPs located in remote facilities through a dial-up switched telephone network and with DCPs in the same facility by Local Area Network (LAN) on a scheduled basis and as directed by a system operator. Every connected analog output (AO), analog input (AI), digital output (DO), pulse input (PI), and digital input (DI) represents a "point" when referred to in the specification.

E. Unitary controllers (UCPs) which are self-contained, stand-alone controllers, could be networked on a sub-network. These unitary controllers (also called application specific controllers) shall be considered "one point" (regardless of the fact that each of these may have several inputs and outputs).

F. Systems that utilize sub-panels in a sub-network, in addition to UCPs, to DCPs shall indicate such panels by the designation DTC (data terminal cabinet). The DTCs are generally considered to denote panels for extending the I/O capacity of the DCP. The DTCs may or may not have their own processor.

G. In general, any control panel connected to the highest level peer-to-peer network shall be called DCP. All panels in a sub-network to the DCPs shall be called DTCs. The application specific controllers (UCPs) may be on a sub-network to DCPs or to DTCs.

H. All equivalency in proposers' hardware shall be clearly identified as such.

I. System Accuracy and Display: All information shall be displayed and printed directly in engineering units with a format consistent with the range selected and matched to the full accuracy

of the sensor, i.e., a static pressure sensor with a range of 0 to 0.25 inch water gauge (w.g.) with an accuracy of 0 to 0.25 percent, will be displayed in a + x.xxxx format.

1. An analog value input to the system's equipment via an AI shall have a maximum error of +0.10 percent of range, not including the sensor or transmitter error. This accuracy is required over the specified environmental conditions.

J. Symbols, Definitions, and Abbreviations: All symbols, definitions, and engineering unit abbreviations utilized in information displays and printouts shall conform to the IEEE Standard Dictionary of Electrical and Electronic Terms and the ASHRAE Handbook of Fundamentals, where applicable.

K. Environmental Conditions:

1. The DCP, Data Terminal Cabinets (DTC) and all other field equipment shall be rated for continuous operation under ambient environmental conditions of 35˚F to 120˚F dry bulb and 5 to 95 percent relative humidity, noncondensing. Equipment installed in a more severe environment shall withstand conditions as specified. If equipment is required to operate in such severe environments, appropriate environmental-type housings shall be furnished in accordance with the specification. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

2. Operator's console shall be designated for continuous operation under ambient environmental conditions of 60˚ to 85˚F and a relative humidity of 20 to 80 percent, noncondensing.

L. Power Line Surge Protection: All equipment connected to AC circuits shall be protected from power line surges. Equipment protection shall meet the requirements of ANSI/IEEE C62.45-1987 and tested to UL 1449-1987. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms.

1. Test 1, Category A: 100 kHz ringwave of 6 kV at 200 amps

2. Test 2, Category B: 100 kHz ringwave of 6 kV at 500 amps

3. Test 1, Category B: 1.2 x 50 at 6 kV biwave; 8 x 20 at 3,000 amps

4. Test 2, Category C: 1.2 x 50 at 6 kV biwave; 8 x 20 at 10,000 amps

M. Sensor and Control Wiring Surge Protection: All digital and analog inputs and outputs shall be protected against surges induced on control and sensor wiring installed outdoors. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms.

1. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

2. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

N. Communication Link Surge Protection: All communication equipment shall be protected against surges induced on any communications link. All cables and conductors, except fiber optics, which serve as communication links from the operator's console to field equipment and between field equipment shall have surge protection installed at each end. Protection shall be furnished at equipment and additional protectors rated for the application on each wireline circuit shall be installed within three (3) feet of the building cable entrance.

O. Power Line Conditioners (PLC): PLCs shall be furnished for all operator's consoles equipment and each DCP. The PLCs shall provide both voltage regulation and noise rejection (both at low frequency and radio frequency). The PLCs shall be of the ferroresonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side.

The PLCs shall be sized for 125 percent of the actual connected KVA load. Characteristics of the PLC shall be as follows:

1. At 85 percent load, the output voltage shall not deviate by more than +1 percent of nominal when the input voltage fluctuates between -25 percent to +15 percent of nominal.

2. During load changes of zero to full load, the output voltage shall not deviate by more than +3 percent of nominal. Full correction of load switching disturbances shall be accomplished within 3 Hertz, and 95 percent correction shall be accomplished within 2 Hertz of the onset of the disturbance.

3. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

4. Minimum electromagnetic interference and radio frequency interference noise rejection shall be:

   a. 20 KHz - 100 MHz - 60 dB normal mode

   b. 20 KHz - 100 MHz - 40 dB common mode

5. All field equipment, including DCPs, DTCs, UCPs, ACPs (if applicable) shall have power line surge protection installed. As a minimum, Hubbell surge suppression receptacles shall be used.

P. The DDC system shall be capable of automatically calling a minimum of nine (9) telephone numbers or alphanumeric pagers. If a called number is busy, repeated attempts shall be made after a user-defined interval until one of the following occurs:

1. The call is answered.

2. The calling process is terminated by the system operator.

3. The alarm condition ceases to exist.

4. The proposers are encouraged to provide various arrangements for achieving this function. It is also a requirement that the system report troubles by calling various alphanumeric pagers. The Owner will supply the details of these pagers.

3.3 DIRECT DIGITAL CONTROL PANELS (DCPS) – ALSO REFERRED TO AS NIP'S

A. Direct Digital Control Panels are the highest level of controller that are connected to the local area network.

1. The DCPs shall be networked together to form a truly distributed control system. Any failure of a single controller (DCP) in the network shall not cause any other controller to fail. The DCPs shall communicate via a peer-to-peer, token passing or Ethernet protocol. Any DCP shall be capable of sharing information with any other DCP, without the need for a network master computer. It shall be possible to share information across the network in real time to be used for control purposes. The amount of time for control information to reach any DCP in the system shall be less than five seconds, regardless of network loading and the number of panels on-line. The network shall be capable of supporting a minimum of 255 DCPs on-line simultaneously. All data shall be displayable and changeable from any DCP in the system. The refresh rate of remote data (data at another DCP) being displayed shall be less than five seconds.

2. DCP shall be microcomputer-based with a minimum word size of 32 bits. (It is suggested that the proposers take exception to this item if necessary.) Output relays associated with digital signals shall be considered part of the Input-Output (I-O) function, whether physically mounted in the enclosure or separately mounted.

3. The DCP shall include:

   a. Main power switch.

b. Pneumatic filter regulator as needed

c. Locks on all cabinets. Locks shall be shall be keyed alike.

4. Sufficient memory shall be provided to perform all specified and indicated DCP functions and operations. Memory shall be a minimum of 640 Kilobytes, expandable to 2 megabytes or larger.

5. The DCP shall contain RAM/EPROM memory expandable to 64 Mbytes.

6. The DCP shall calculate in floating point arithmetic. Fixed point arithmetic units will not be accepted.

7. Each DCP shall have its own real time clock (RTC) with long-life battery back-up. The DCP shall systematically synchronize clock with the master clock in the system.

8. A watchdog timer shall be provided in the system to supply a contact closure if the system fails to scan for any two-second interval.

9. Internal back-up battery shall be provided on each DCP if the program is not contained in non-volatile memory. This back-up shall be for minimum of 72 hours.

10. The analog inputs to the DCP or DTC shall be as follows:

    a. Minimum analog to digital (A/D) conversion shall be 12 bits.

    b. Input range shall be 4-20 ma current loop or industry standard 0-5 volts or 0-10 volts or 1000 ohm RTD.

    c. Operating temperature shall be 32˚F to 130˚F, relative humidity 5 percent to 90 percent noncondensing.

11. The analog output shall have minimum of 10 bits resolution for digital to analog (D to A) conversion. The output signal shall be 4-20 ma or industry standard 0-10 volts.

12. The binary inputs/output (BI, BO) shall be selectable universal inputs or outputs and have the following minimum requirements.

    a. Binary inputs shall be close contact, 24 volts to 240 volts AC or DC.

    b. Binary output shall be 24 volts to 240 volts AC, switching to 3.0 amps.

    c. Operating temperature shall be 32˚F to 130˚F, operating humidity shall be 10 percent to 90 percent non-condensing.

13. DCP Communications Equipment.

    a. Certification: MODEMS shall be certified to meet the requirements of FCC Rules and Regulations, Part 68, and other applicable regulations.

    b. Automatic Answer MODEMS: MODEMS shall be suitable for connection to the dial-up telephone network and shall provide for transmission speeds of at least 2400, 9600 baud and 56k baud with auto baud rate selection. MODEMS shall provide for automatic answer of all incoming calls.

14. A dedicated 120 volt AC, 15 amp, 60 Hz duplex outlet shall be furnished either inside or within 6 feet of the DCP enclosure.

15. DCPs shall be housed in locking type mounting cabinets, with common keying and door switch. The DCP doors shall be alarmed and shall be monitored continuously and reported at the operator's console.

16. Data Control Panel (DCP):

    a. Each DCP shall have 20 percent spare capacity for I/O expansion after all the equipment has been connected to it, with 20 percent spare capacity for the building.

b. The DCP shall be provided with double-sided screw type terminal strips. One side of the terminal strip shall be used for termination of field wiring from instrumentation and controls. Terminal strip shall accept 12AWG stranded wire. The other side shall be used for connection to the DCP. All DCP and DTC circuit boards shall be plug-in type. Terminal strips shall have individual terminal identification numbers.

c. The DCPs shall have at least one spare RS-232 serial port in order to accommodate a remote operator's CRT either by direct hardwire or via auto answer phone modem.

17. DCP Portable User Interface Device: Portable user interface devices for connection to any DCP shall be provided. Each DCP shall have the ability to accept connection of the portable user interface device to it. This interface device shall be ANSI X3.64 compatible and shall include a keyboard and display. The Owner shall supply this equipment. Coordinate the requirements with the Owner. The interface available at each DCP, shall include the following features:

a. Initiate DCP Diagnostics

b. Display any digital and analog input, output or calculated point in the entire networked system at a summary and detailed level. Any dynamic information on any display, such as point value and status, shall be refreshed. The refresh rate shall be less than five seconds for all data.

1) The operator interface shall be menu driven, allowing the operator to be directed in English language. System using codes or hexadecimal addresses shall not be acceptable.

2) The data shall be obtained in multi-level hierarchical displays, such that data regarding a selected (highlighted) item on Level 1 can be displayed in full screen detail on Level 2.

3) Displays referring to points, strategies, and equipment shall be user definable by the use of path names and wild carding.

4) The summary level point display shall include, as a minimum, the point identifier, value, and status for a group of points. It should be possible for a group of points to span different DCPs.

5) The detailed level point display information shall include, as a minimum, all user defined attributes of the point, such as point limits, alarm priority, etc. These attributes are in addition to the point value and status, which appear at the point summary level.

a) Modify any digital and analog input, output, or calculated point in the entire networked system at both the summary and detailed level.

6) All information which the user can display as described above the user may change while it is being displayed. The user should be able to modify, as a minimum, all point values and statuses at the summary level. The user should be able to modify pertinent point attributes which may be displayed at the detailed level, including alarm limits, alarm priority, and hardware channel address as a minimum.

7) Any input value, whether on this DCP or another DCP, which is modified by the user, shall automatically go to an off-line status to allow the user to quickly override any input in the system.

8) Any output or calculated value, whether on this DCP or another DCP, which is modified by the user, shall automatically go to a control

override state. This will allow the user to quickly and immediately override any output or calculated point in the system.

a) It shall be possible to set all of the local real time clocks in all DCPs and modify the program in any or all DCPs (using appropriate passwords).

9) DTCs: the subpanels under the DCPs used to extend the data environment (DE) shall generally follow the same specifications for various types of I/O as the DCP.

10) The DCPs, DTCs, and UCPs shall not use fixed-point arithmetic. Any system using fixed-point arithmetic shall not be considered to meet the specification. There shall be no exceptions to this requirement.

11) I/O Functions:

a) Analog Inputs (AI): The AI function shall monitor each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation. Signal conditioning shall be provided for each analog input as necessary. Individually calibrate all analog inputs for zero and span, in hardware or in software. Input ranges shall be in the range of 4-20 mA DC. AI shall be a minimum of 12 bit resolution.

b) Analog Outputs (AO): The AO function shall accept digital data, perform D-to-A conversion, and output a signal in the range of 4-20 mA DC. Individually calibrate all analog outputs for zero and span. Short circuit protection on voltage outputs and open circuit protection on current outputs shall be provided. AO shall be minimum of 12 bit resolution and be a sourcing type signal.

c) Digital Inputs (DI): The DI function shall accept DE on-off, open-close, or other change of state (two state data) indications. Isolation and protection against an applied steady-state voltage up to 350 volt AC peak shall be provided. Fuses shall not be used for this purpose.

d) Digital Outputs (DO): The DO function shall provide contact closures for momentary and maintained operation of output devices. Closures shall remain closed for not less than 0.1 second. Electromagnetic interference suppression shall be furnished on all output lines to limit transients to non-damaging levels. Digital outputs shall be provided with solid state opto isolation with zero crossover for 3A. The digital outputs shall be fused for circuit protection.

e) Pulse Accumulator: The pulse accumulator function shall have the same characteristics as the DI, except that, in addition, a buffer shall be provided to totalize pulses and allow for interrogation by the DCP. The pulse accumulator shall accept rates up to 30 pulses per second. Contact debouncing circuits, if required, shall be furnished by the DDC System Supplier.

f) Signal Conditioning: Signal conditioning for sensors shall be provided as specified.

12) Provide completed details on the types of application specific panels (UCPs) that are available. In general, UCPs shall only be used on various types of terminal equipment.

3.4 DATA TERMINAL CABINETS

A. The data terminal cabinets, also known as DTCs, are essentially extender panels to increase the point capacity of the DCP.

B. The DTC may be an integral part of the DCP or may be separate from the DCP.

C. The DTC shall be sized to accommodate the number of I/O functions required for each DCP. Each DCP as installed shall be provided with the capability for 25 percent expansion capability without a change in the DCP computer memory. This expansion may be provided by future addition of DTCs.

D. The DTC shall be divided into analog and digital groupings, each with separate sensor and control signal wiring raceways.

E. The DTCs shall be provided with screw type terminal strips. The terminal strip shall be used for termination of field wiring from instrumentation and controls. All DTC terminal strip connections to the DCP or data buss shall be plug-in type. Terminal strips shall have individual terminal identification numbers.

F. All DC power supplies, interposing relays, and current to pressure transducers shall be located in the DTCs or in other ACPs.

G. All DTCs shall be housed in locking type mounting cabinets with common keying and with door switch. Door switch shall alarm the DDC system monitoring station that the door is open. Refer to paragraph on apparatus control panels and other enclosures in this part of the specification for further requirements.

H. All data cabinets shall be painted to match mounting wall color. Coordinate with Architect for finish colors.

3.5 UNITARY "APPLICATION-SPECIFIC" CONTROL PANELS (UCPS)

A. Where specified, the DDC System Supplier shall furnish UCPs. UCPs are panels with built-in microprocessors used to control terminal equipment such as VAV terminal boxes, VAV terminal boxes with reheat, and fan coil units.

B. UCPs shall be stand-alone microprocessor based control devices with networkable input and output capability. The device shall have sufficient memory to provide all specified operational functions. Refer to control sequences for requirements.

C. All UCPs shall be networked to the higher level DCPs via a sub-network for monitoring and control from the central or remote operator's console level using non-proprietary public unitary protocol (PUP).

D. It shall be possible to use UCPs from the same manufacturer on the same sub-network under a DCP if UCPs don't use PUP. The proposed system shall be able to use unitary controllers from all manufacturers that have open protocol.

E. All UCPs shall have a jack receptacle provided at the thermostat for field operator communication to other UCPs on the network.

F. Each UCP shall have sufficient I/O termination capacity for the specific application and spare capacity as specified in the General requirements..

G. Enclosures for UCP circuit boards and terminal strips shall be plug-in type.

H. Enclosures for UCPs will be NEMA 1 type or better.

I. The low voltage power supply transformers, the transformer surge protection receptacle, and circuit protection for UCPs shall be furnished by the DDC System Supplier as required. No UCP shall be installed without providing minimal surge suppression in the power line, such as Hubbell surge suppression receptacles.

3.6 [NOT USED]

3.7 OPERATORS CONSOLES - CENTRAL STATION

A. The DDC System Supplier shall provide computer equipment specified for this application.

B. This section lists the minimum requirements generally appropriate for an operator console located in the central station for the site.

C. For the estimation of installation, the DDC System Supplier shall assume that the location of this equipment is within 300 feet of an area where access to the LAN is available. For distances beyond this, a per-foot cost shall be negotiated.

D. The central station operator console shall include the following items. (See subsequent sections for details of equipment.)

1. Computer and Accessories

   a. ProLiant DL380 G3 Intel Xeon Processor 3.06 GHz – Rack Model (Part #310587-001)

   b. Intel Xeon Processor 3.06 GHz / 512KB Processor Option Kit (Part #257916-B21)

   c. 72.8-GB 10,000 rpm U320 Universal Hard Drive (Part #286714-B22)

   d. DL380 G3 Redundant Fan Option Kit (Part#293048-B21)

   e. HP NC7771 PCI-X Gigabit Server Adapter (Part#290563-B21)

   f. ProLiant Essentials Integrated Lights-Out Advanced Pack (Part#263825-B21)

   g. Compaq Hot Plug AC Redundant Power Supply Module (Part#313054-001)

   h. Operating system shall include Windows 2000 Server with SP3 Web Server and Microsoft Internet Information Server 5.0 or higher

   i. Web Browser shall be Internet Explorer 6.0 or later

   j. Microsoft SQL Server 2000 Database software

2. Read/Write CD ROM/DVD drive

3. High Resolution (minimum 1280 x 1024), 17 flat panel display

4. Keyboard

5. Optical mouse

E. The DDC System Supplier shall provide the network cards and all interfaces for fiber optic cables as required.

3.8 PERIPHERAL EQUIPMENT FOR OPERATOR CONSOLES

A. Provide all peripheral equipment for the operator console and central station, such as keyboard, mouse, colored monitor, various types of printers, disk storage systems, , phone modems, etc.

B. A full function keyboard shall be furnished with the operator's console. The keyboard shall include a 96-character standard ASCII character set numeric keypad and 12 programmable function keys. The keyboard shall provide a means for the operator to interact with all command and applications software.

C. Provide a three-button, multi-function mouse and mouse pad for graphic interaction with the computer system.

3.9 AUDIBLE ALARMS

A. An audible alarm shall be provided at the central station operator's console and at various auxiliary operators’ consoles as specified. The alarm shall incorporate the following features:

1. Adjustable volume control.

2. Disable switch to disable the alarm and relay when not in use.

3. Relay to set off alarm and hold alarm "on" upon a momentary alarm contact.

4. Reset switch to acknowledge and turn "off" alarm after each alarm and to reset relay. The acknowledgement for the alarm shall be documented by the DDC System Supplier.

3.10 COMPUTER PRINTER – FUNCTIONALITY SHALL BE PROVIDED TO TRANSMIT ALARMS TO ALPHA NUMERIC PAGERS VIA SMTP COMPUTER PRINTER

A. This printer shall be a network printer HP Laserjet 2300N or equal and must be TCP/IP compatible used at all other operator consoles other than the Central Station.

B. Provide the following equipment at the locations shown:

1. Printers for operator console. Provide the following printers for the main operator console.

a. Laser printer. Provide high quality laser printer with two paper trays with 500 page capacity each. Provide printer cable and 2 spare toner cartridges. Provide a minimum of four built-in fonts with capability to add font cartridges. The equipment shall be HP Lazerjet 2300N or equal and must be TCP/IP compatible.

b. Alarm printer. Provide 24 pin dot matrix printer for logging alarms from the system. This printer shall accept fan-fold paper with micro-perf edges. The paper size shall be 8-1/2 inches wide. Provide printer cable. The printer shall come on with "on line" status by default. The operator shall not have to put the printer on-line after turning on power. The printer shall be 75 percent duty. The print resolution shall be adjustable at the front and through software. The acceptable manufacturers are Epson, Panasonic, and Okidata.

3.11 [NOT USED]

3.12 DCP PORTABLE USER INTERFACE DEVICE – LAPTOP

A. Computer Platform 3 GHz Pentium with 1 GB of RAM

B. 40 GB free hard disk space available

C. CD-RW

D. Operating System Microsoft Windows 2000 Professional with SP3 or Microsoft Windows XP Professional with SP1

E. Web Browser Microsoft Internet Explorer Version 6.0 or later. See Table 2 for more details.

F. Communication Ethernet network interface card 10/100 Mbs (100 Mbs recommended) internal modem

G. Minimum 3 USB Ports

H. Internet Explorer 6.0 or later

I. Microsoft Office Professional Edition, latest edition.

J. DDC System Operator Workstation Application(s), latest revision.

K. Any other software required to deliver the specified performance.

3.13 INSTRUMENTATION - SENSORS, TRANSMITTERS, ACTUATORS, ETC.

A. The DDC System Supplier shall be advised strict adherence to performance criteria and accuracy of instrumentation will be a requirement. In general, standard commercial grade components will not meet some of the criteria. The sequences of control shall specify the grade of instrumentation

to use for various applications. The I/O summaries for control sequences shall provide this information. The transmitters for both Grades A and B instruments are the same. Grade C instrumentation may or may not require a 4-20 ma transmitter. The definition of instrumentation is as follows:

1. Grade A Instrumentation: This type of instrumentation is of the highest quality and shall be used in all laboratory spaces.

2. Grade B Instrumentation: This type of instrumentation is of high quality industrial and semi-industrial instrumentation, with accuracies typically in the rage of 0.5 percent to 1.0 percent. This type of instrumentation shall be used for applications requiring accurate control of main air handling units, chillers, and controls for spaces such as class rooms, conference rooms, offices, and atriums.

3. Grade C Instrumentation: This type of instrumentation shall be used for unit heaters, cabinet heaters, and similar equipment serving mechanical equipment rooms, stairwells, etc.

B. Transmitters Instrumentation

1. Transmitters: the term "transmitter" is defined as the electronic circuitry that accepts the signal from the sensor and after conditioning (if needed) transforms it into a 4-20 ma, or 0-10 VDC, signal. The term transmitter does not include the sensor which is also termed as transducer. It is also assumed in the specification that the transmitters on most industrial type sensors are to be located next to the sensor (transducer). Where indicated, the transmitters with field adjustable rangeability shall be provided. It shall be noted that all transmitters for Grade A and B instrumentation shall provide 4-20 ma or 0-10 VDC output Specialized sensors with other types of outputs may be allowed with prior approval only on a case-by-case basis.

   a. All sensors, except the binary sensors, and temperature sensors shall be provided with a 4-20 ma DC or 1-10 volt DC output type transmitters, or RTD's suitable for the sensor being used. The accuracy of the transmitter shall be $\pm$0.5 percent of the span. The stability shall be $\pm$0.012 percent of span/degree centigrade change in ambient temperature. The linearity shall be $\pm$0.05 percent of span. The transmitter shall be protected against damage caused by reverse polarity and supply voltage transients. The span required shall depend on the particular sensor and the application. A span and zero adjustment shall be provided at each transmitter to allow for recalibration when necessary. The transmitter circuitry shall be housed in an enclosure appropriate for the application and in conformance with NEC and Montgomery County, MD, requirements. The operating temperature limits for ambient conditions shall be 32˚F to 122˚F or otherwise if stated for special applications.

2. The requirements listed above for transmitters serves to indicate the performance for this electronic component. The accuracy listed for sensors is assumed to include the requirements for the transmitters.

3. Transmitters for Grade A and Grade B shall have switch-selectable ranges on the transmitter (e.g., 35˚F to 60˚F may be represented by 4-20 ma instead of -40˚F to 150˚F, etc.). Software range changes shall be acceptable.

4. Where platinum RTD temperature sensors are specified in this section, 10 k-ohm thermistors are acceptable. Thermistors less than 10 k-ohm are acceptable only when a transmitter is required.

C. [not used]

D. Sensors for Grade A Instrumentation. These sensors are for use in laboratory areas.

1. Space Temperature Transducers shall be 10k ohm thermister transducer. The sensor shall meet the following specifications:

a. Accuracy: +0.2 percent of span

b. Stability: +0.2 percent of span for six months

c. Linearity: +0.05 percent of span

d. Span: 50˚F minimum

e. Temperature Limits Ambient: -40˚F to 160˚F

f. Temperature Range: as required by application

2. Duct and Liquid Temperature Transducer. The sensor shall meet the following specifications. Transmittors used in liquid service shall be supplied with three (3) inch lagging extension stainless wells.

a. Accuracy: +0.2 percent of span

b. Stability: +0.2 percent of span/degree C

c. Linearity: +0.05 percent of span for six months

d. Span: 50˚F minimum

e. Temperature Limits Ambient: -40˚F to 160˚F

f. Temperature Range: as required by application

3. Differential Temperature Transmitters shall be factory calibrated, field calibration or adjustment is not permitted. The transmitter shall be protected against damage from reverse polarity and line transients. The transmitter shall meet the following specifications:

a. Accuracy: +0.5 percent of span

b. Stability: +0.01 percent of span for six months

c. Linearity: +0.05 percent of span

d. Span: 25˚F maximum

e. Temperature Limits Ambient: 32˚F to 122˚F

4. Static Pressure Transducer: The range shall be selected to operate at approximately 75% of the range of the sensor.

a. Accuracy: +0.25 percent

b. Long-Term Stability: +1 percent of span per year

c. Span: 0.25 inch wc minimum to 10 inch wc maximum span

d. Ambient Temperature: 50˚F to 100˚F

e. Overpressure: 25 inch ws without damage

f. Power Supply: 24 to 40 volts DC at 30 ma

g. Output: 1 to 5 volts DC or 4-20 ma

h. Reliability: MTBF = 20,000 hours

i. Noise: 2 mV RMS

j. Power Supply Variation: +0.03 of span

5. Differential Pressure Transducer: The range shall be selected to operate at approximately 75% of the range of the sensor.

a. Accuracy: +0.25 percent of span

b. Long-Term Stability: +1 percent of span per year

c. Span: 0.25 inch wc minimum to 10 inch wc maximum span

d. Overpressure: 25 inch ws without damage to 10 inch wc maximum span

e. Output: 1 to 5 volts DC or 4-20 ma, 0-10 VDC

f. Ambient Temperature: 50˚F to 100˚F

g. Reliability: MTBF = 20,000 hours

6. Gauge Pressure: The pressure transmitter shall incorporate direct electronic sensing with a completely sealed pressure cell. The unit shall use a differential capacitance sensing element that eliminates mechanical force transfer and the associated problems with vibration, shock and temperature.

a. Functional

1) Overpressure: 2000 psig without damage

2) Temperature: -20˚F to +200˚F

3) Output: 4-20 ma DC, 0-10 VDC

4) Span: 5 inch wc minimum to 6000 psig maximum span

b. Performance

1) Accuracy: +0.25 percent of span

2) Linearity: +0.10 percent of span

3) Hysteresis: +0.05 percent of span

4) Repeatability: +0.05 percent of span

5) Long-Term Stability: +0.25 percent of span per six months

7. Differential Pressure: The pressure transmitter shall incorporate direct electronic sensing with a completely sealed pressure cell. The unit shall use a differential capacitance sensing element that eliminates mechanical force transfer and the associated problems with vibration, shock and temperature.

a. Functional

1) Overpressure: 2000 psig without damage

2) Temperature: -20˚F to +200˚F

3) Power Supply: 24 to 40 volts DC at 30 ma

4) Output: 4-20 ma DC

5) Span: 5 inch wc minimum to 750 inch wc maximum span

b. Performance

1) Accuracy: +0.20 percent of span

2) Linearity: +0.10 percent of span

3) Hysteresis: +0.05 percent of span

4) Repeatability: +0.05 percent of span

5) Long-Term Stability: +0.20 percent of span per six months

8. Liquid Flow Meter: Flow transmitters shall be of a two-wire 4-20 ma type, operating on a vortex shedding principle and provide a current signal linear with flow. Transmitters shall be factory wet calibrated, field calibration or adjustment is not permitted. The

transmitter shall be protected against damage from reverse polarity and line transients. The transmitter shall meet the following specifications:

a. Accuracy: +0.5 percent of rate

b. Repeatability: 0.5 percent of span

c. Rangeability: 20:1

d. Temperature Limits: -40˚C to +750˚C

e. Ambient: -40˚C to 140˚C

f. Response Time: 1.0 sec

g. Pressure Drop: 0.0025

h. Linearity Range: 20,000 to 3,000,000 Reynold's Number

9. Electronic Air Flow Transducers: Transducers are electronic monitors of air mass flow in ducts. They measure mass flow directly, monitor low flows down to 0-100 SFPM, and do not need pneumatic hook-ups, square-root extractors or temperature and pressure corrections.

a. Accuracy: 3 percent FS over 32˚F to 122˚F

b. Repeatability: 1 percent FS

c. Response Time: 300 ms (to 63 percent of final flow)

d. Range: 0 to 200 FPM - 0 to 2000 FPM

e. Temperature: -4˚F to 212˚F

f. Output Signal: 100 to 300 ma

g. Input Power: 24 volts DC

10. Current to Pressure Transducer (I/P) shall be of industrial quality and capacity. Motor driven PRVs, switching solenoid valves, or position sensitive devices are not acceptable. The current to pressure transducer shall meet the following specifications:

a. Supply Pressure: 25 psig +2 psig

b. Linearity: +0.5 percent of span

c. Span: 3-15 psig

d. Flow Rate: 4.5 SCFM @ 25 psig supply pressure

e. Air Consumption: 0.25 SCFM

11. Reheat Valve:

a. Valves up to and including 1-1/4 inches shall have union connections. Valves 1-1/2 inches shall have screwed ends. All valves 2 inches and less in size shall be of high grade bronze. All valves 2-1/2 inches and larger shall have flanged ends, cast iron bodies and positive positioners.

b. All 2-way reheat control valves shall be PICCV characteristic ball valves by Belimo with corresponding actuator.

c. All 3--way reheat control valves shall be CCV characteristic ball valves by Belimo with corresponding actuator.

12. Dampers

a. Provide Ruskin CD60

b. Provide airflow opposed blade dampers and control dampers of the size indicated with a pressure class of not less than 150 percent of the system at shut-off pressures capable of being developed by the related fan system.

c. Dampers shall be selected to provide correct flow control characteristics as required for each individual application.

d. Single blade height control dampers and room dampers shall be single blade dampers.

e. The operating range shall be -50˚F to 200˚F.

f. All control dampers, including outdoor, return, relief and mixing box dampers, will be furnished by the DDC System Supplier. Control dampers shall be substantially built, steel frames fabricated from 2-inch channel or equal. Frames shall be substantially built, steel frames fabricated from 2 inch channel or equal. Frames shall be equipped with brass trunions and bearings and blade end stops. All damper blades shall be galvanized steel. The maximum blade width shall be 10 inches. Provide corner braces for all damper frames exceeding a 4 square foot area. Maximum width of any section shall be 48 inches and the maximum section height shall be 96 inches. Provide horizontal stiffening for any section exceeding 48 inches in height. Dampers for outdoor air, relief air and exhaust air applications shall be provided with neoprene seals on blade edges and end stops. All dampers shall be provided with appropriate seals along the blade edges and at blade ends to provide tight closure with minimum leakage. Air leakage in the damper closed position shall not exceed 15 CFM per square foot of damper or 5 percent of the flow, at 6 inches water gauge differential.

g. All low leakage dampers shall be provided with a substantial damper actuator and linkage capable of delivering the required force of torque needed for obtaining rated performance of the damper.

h. Single widths of dampers up to 4.0 square feet shall be provided with extended damper shafts, adjustable lever arm, damper motor, and motor mounting bracket.

i. Single widths of dampers in excess of 4.0 square feet shall be provided with a direct drive system consisting of an eye bracket mounted directly onto a damper blade or onto the damper linkage, damper motor and a motor mounting bracket. A duct access door shall be provided for periodic inspection, maintenance and adjustment.

j. Multiple widths of dampers in excess of 48 inches wide shall be provided with multiple damper motor or with a jack shaft system; use of jumper brackets is prohibited. The jack shaft system shall consist of the following: a 1-inch diameter shaft running the full width of the duct and extended to one side for attachment of the damper motor, bushing type pillow blocks mounted maximum 5 feet on center along the jack shaft, lever arms (one for each damper section and one for the damper motor)eye brackets mounted directly onto a damper blade in each damper section, adjustable linkages between the jack shaft lever arms and the damper blade eye brackets, a damper motor, and a motor mounting bracket. Provide access doors at each lever arm location for periodic inspection, adjustment, and maintenance. Following final adjustment, tack weld each lever arm to the jack shaft.

k. Additionally, the damper shall have the following characteristics:

1) Type: Low leakage

2) Frame: 5 inches by 16 gauge hat-shaped steel

3) Blades: Air foil double skin 14 gauge

4) Seals: Blade edge-extruded vinyl; jam-aluminum flexible compression type

5) Linkage bearing: concealed in frame

6) Axles: molded synthetic 1/2 inch plated steel hex mill galvanized

7) Maximum Temperature: 250˚F

13. [not used]

14. Damper Actuators

a. Actuators shall be electric (electronic).

b. All actuators shall be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as shown. Normally open and normally closed actuators shall be of mechanical spring return type.

c. Electric actuators shall have an electronic cut off or other means to provide burnout protection if stalled. Actuators shall have a visible position indicator.

d. Electric actuators shall provide position feedback to the controller as shown. Actuators shall smoothly open or close the devices to which they are applied.

e. Electric actuators shall have a full stroke response time in both directions of 60 seconds or less at rated load. Electric actuators shall be the direct-coupled type.

f. Where multiple electric actuators operate from a common signal, the actuators shall provide an output signal identical to its input signal to the additional devices.

g. Valve Actuators: Valve actuators shall provide shut-off pressures and torques for the corresponding flow rates and system pressures.

h. Damper Actuators: Damper actuators shall provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque shall be at least 6 inch-pounds per 1 square foot of damper area for opposed blade dampers and 9 inch-pounds per 1 square foot of damper area for parallel blade dampers.

i. Positive Positioning Devices: Positive positioning devices shall be a pneumatic relay with a mechanical position feedback mechanism and an adjustable operating range and starting point.

15. [not used]

16. Straightening vanes shall be manufactured in accordance with recommendations of ASME, shall be a minimum of two (2) "diameters" in length, and shall be suitable for mounting in the pipe line without flanges. Straightening vanes shall be equal to Daniel Carbon Steel Straightening Vanes.

17. Isolation valves and tubing shall be in accordance with Section 15050 requirements for the project.

18. Provide retractable insertion type target flow meters complete with isolation valve and mechanical insertion mechanism. All valves, piping, seals and the insertion mechanism shall be rated for the line pressures stated in Division 23 of the specification. Target flow meter shall be equal to Hershey Ramapo Mark V strain gauge target flow meter.

a. Fluid service: Chilled water; hot water; glycol water

b. Pressure: 500 psig minimum for sensing element

c. Temperature: 0˚F to 350˚F

d. Range: 10:1 (30:1 on application; 20:1 more likely)

e. Accuracy: 0.5 percent of full scale

f. Repeatability: 0.15 percent of rate

19. Watthour Transducers: watt or watthour transducers shall meet the following specifications:

a. Accuracy: ±0.2 percent of full reading (full lead to full lag power factor)

b. Potential Input: Either direct connect or potential transformers as required

c. Current Input: Must use current transformers

d. Auxiliary Power: As required

e. Frequency Response: Flat from 0 Hz to 5 kHz

f. The potential and current transformers shall be of split core design.

20. High-pressure transmitters shall be solid-state devices with no moving parts and with 4-20 ma output when used in conjunction with an external power supply.

a. Pressure transmitters shall meet the following specification:

1) Range: Factory calibrated to 125 percent of required maximum pressure for specified service and location

2) Accuracy: ±0.25 percent of range

3) Repeatability: ±0.05 percent of range

4) Damping: 0.2 to 1.67 seconds (continuously adjustable)

5) Operating Temperature: -20˚F to 200˚F

6) Pressure Limits without Damage: 0-500 psig for chilled water. 0-200 psig for hot water and steam

b. The following accessories shall be provided with each transmitter:

1) Side vent/drain.

2) Isolation valve at transmitter connection.

3) Transmitter mounting bracket.

c. Pressure transmitter shall be Rosemount 5131 Series.

d. On submittal data, specify transmitter tag, proposed device's standard service range and proposed calibrated range for each device furnished.

21. Humidity Sensor: Humidity transmitter shall be two-wire, 4-20 ma output sensing device using bulk polymer resistance sensor technology.

a. Transmitters shall meet the following specifications:

1) Accuracy: ±1 percent RH

2) Span: 15 percent to 95 percent RH

3) Operating Temperature Range: 30˚F to 120˚F minimum

4) Temperature Affect: ±0.06 percent per degree centigrade change in ambient temperature

5) Manufacturer: Veris HT Series

b. Where temperature and humidity are being measured in the same room, the temperature and humidity transmitter shall be mounted on a common mounting bracket and covered with a common cover.

c. The humidity transmitter shall not be damaged when moisture condenses on the sensor itself.

22. Occupancy sensors: Occupancy sensors: Sensors are provided by the electrical contractor.

23. Air Flow stations for laboratory spaces with fumes hoods shall either comply with Part 6 of this specification or be Ebtron Gold series air flow stations. Refer to the drawings for type.

E. Sensors for Grade B instrumentation. These are for use in large Air Handling Units, Central Pants components and non-laboratory spaces.

1. Space Temperature Transducers shall be factory calibrated. The sensor shall meet the following specifications:

a. Accuracy: $\pm$1.0 percent of span

b. Stability: $\pm$0.01 percent of span/degree C

c. Linearity: $\pm$0.05 percent of span

d. Span: 50˚F minimum

e. Temperature Limits Ambient: 32˚F to 122˚F

2. Duct and Liquid Temperature: Transducers Sensors used in liquid service shall be supplied with three (3) inch lagging extension stainless wells.

a. Accuracy: $\pm$0.5 percent of span

b. Stability: $\pm$0.01 percent of span/degree C

c. Linearity: $\pm$0.05 percent of span

d. Span: 50˚F minimum

e. Temperature Limits Ambient: 32˚F to 122˚F

3. Differential Temperature Transmitters shall be factory calibrated, field calibration or adjustment is not permitted. Transmitters shall be protected against damage from reverse polarity and line transients. The transmitter shall meet the following specifications:

a. Accuracy: $\pm$1.0 percent of span

b. Stability: $\pm$0.01 percent of span/degree C

c. Linearity: $\pm$0.05 percent of span

d. Span: 25˚F maximum

e. Temperature Limits Ambient: 32˚F to 122˚F

4. Static Pressure Transducer: The operating range shall be selected to operate at approximately 75% of the range of the sensor.

a. Accuracy: $\pm$0.5 percent of span

b. Long-Term Stability: $\pm$1 percent of span per year

c. Span: 0.25 inch wc minimum to 10 inch wc maximum span

d. Overpressure: 25 inch ws without damage

e. Power Supply: 24 to 40 volts DC at 30 ma

f. Output: 1 to 5 volts DC, 0-10 VDC, 4-20 MA

5. Differential Pressure Transducer:

a. Accuracy: ±0.5 percent of span

b. Long-Term Stability: ±1 percent of span per year

c. Span: 0.25 inch wc minimum to 10 inch wc maximum span

d. Overpressure: 25 inch ws without damage

e. Power Supply: 24 to 40 volts DC at 30 ma

f. Output: 1 to 5 volts DC, 0-10 VDC, 4-20 MA

6. Gauge Pressure: The pressure transmitter shall incorporate direct electronic sensing with a completely sealed pressure cell. The unit shall use a differential capacitance sensing element that eliminates mechanical force transfer and the associated problems with vibration, shock and temperature.

a. Functional

1) Overpressure: 2000 psig without damage

2) Temperature: -20˚F to +200˚F

3) Power Supply: 24 to 40 volts DC at 30 ma

4) Output: 4-20 ma DC

5) Span: 5 inch wc minimum to 6000 psig maximum span

b. Performance

1) Accuracy: ±0.25 percent of span

2) Linearity: ±0.10 percent of span

3) Hysteresis: ±0.05 percent of span

4) Repeatability: ±0.05 percent of span

5) Long-Term Stability: ±0.25 percent of span per six months

c. Physical

1) Diaphragms: 316ss

2) Process Flanges: Carbon steel

3) Process Connections: 1/4 NPT

7. Differential Pressure: The pressure transmitter shall incorporate direct electronic sensing with a completely sealed pressure cell. The unit shall use a differential capacitance sensing element that eliminates mechanical force transfer and the associated problems with vibration, shock and temperature.

a. Functional

1) Overpressure: 2000 psig without damage

2) Temperature: -20˚F to +200˚F

3) Power Supply: 24 to 40 volts DC at 30 ma

4) Output: 4-20 ma DC

5) Span: 5 inch wc minimum to 750 inch wc maximum span

b. Performance

1) Accuracy: ±0.20 percent of span

2) Linearity: ±0.10 percent of span

3) Hysteresis: ±0.05 percent of span

4) Repeatability: ±0.05 percent of span

5) Long-Term Stability: ±0.20 percent of span per six months

c. Physical

1) Diaphragms: 316ss

2) Process Flanges: Carbon steel

3) Process Connections: 1/4 NPT

8. Liquid Flow Meter: Flow transmitters shall be of a two-wire 4-20 ma type, operating on a vortex shedding principle or a retractable insertion target meter and provide a current signal linear with flow. Transmitters shall be factory wet calibrated, field calibration or adjustment is not permitted. The transmitter shall be protected against damage from reverse polarity and line transients. The transmitter shall meet the following specifications:

a. Accuracy: ±1.0 percent of rate

b. Repeatability: 0.2 percent of span

c. Rangeability: 20:1

d. Temperature Limits: -40˚C to +215˚C

e. Ambient: -40˚C to +65˚C

9. Space Static Pressure Probe shall allow accurate space static measurement in the presence of radial air velocity sources. The probe shall be specifically designed for ceiling mounting.

a. Accuracy: 1 percent of reading @ 1000 FPM Radial

b. Weight: Velocity

c. Finish: 8 oz. Brushed Anodized Aluminum

10. Air Flow Measurement Stations shall be complete with flow straightening section, multiple self-averaging velocity and static measurement probes, housed in a flanged duct section.

a. Accuracy: ±5 percent

b. Repeatability: ±0.2 percent

c. Temperature: -200˚F to 420˚F

11. Electronic Air Flow Transducers: Transducers are electronic monitors of air mass flow in ducts. They measure mass flow directly, monitor low flows down to 0-100 SFPM, and do not need pneumatic hook-ups, square-root extractors or temperature and pressure corrections.

a. Accuracy: 3 percent FS over 32˚F to 122˚F

b. Repeatability: 1 percent FS

c. Response Time: 300 ms (to 63 percent of final flow)

d. Range: 0 to 200 FPM - 0 to 2000 FPM

e. Temperature: -4˚F to 212˚F

f. Output Signal: 100 to 300 ma

g. Input Power: 24 volts DC

12. Current to Pressure Transducer (I/P) shall be of industrial quality and capacity. Motor driven PRVs, switching solenoid valves, or position sensitive devices are not acceptable. The current to pressure transducer shall meet the following specifications:

a. Supply Pressure: 25 psig $\pm$2 psig

b. Linearity: $\pm$1.0 percent of span

c. Span: 3-15 psig

d. Flow Rate: 4.5 SCFM @ 25 psig supply pressure

e. Air Consumption: 0.25 SCFM

13. Reheat Valve:

a. Valves up to and including 1-1/4 inch shall have union connections. Valves 1-1/2 inch shall have screwed ends. All valves 2 inches and less in size shall be of high grade bronze.

b. All 2-way reheat control valves shall be PICCV characteristic ball valves by Belimo with corresponding actuator.

c. All 3--way reheat control valves shall be CCV characteristic ball valves by Belimo with corresponding actuator.

14. Dampers: Provide control dampers of the size indicated with a pressure class of not less than 150 percent of the system pressure at shut-off pressures capable of being developed by the related fan system. Dampers shall be selected to provide correct flow control characteristics as required for each individual application. Single blade height control dampers and room dampers shall be single blade dampers. The operating range shall be -50˚F to 200˚F.

a. Provide Ruskin CD60

b. Type: Low leakage

c. Frame: 5 inch by 16 gauge hat-shaped steel

d. Blades: Air foil double skin 14 gauge

e. Seals: Blade edge-extruded vinyl; jam-aluminum flexible compression type

f. Linkage bearing: concealed in frame

g. Axles: molded synthetic 1/2 inch plated steel hex mill galvanized

h. Maximum Temperature: 250˚F

15. Damper Actuators

a. Actuators shall be electric (electronic).

b. All actuators shall be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as shown. Normally open and normally closed actuators shall be of mechanical spring return type.

c. Electric actuators shall have an electronic cut off or other means to provide burnout protection if stalled. Actuators shall have a visible position indicator.

d. Electric actuators shall provide position feedback to the controller as shown. Actuators shall smoothly open or close the devices to which they are applied.

e. Electric actuators shall have a full stroke response time in both directions of 60 seconds or less at rated load. Electric actuators shall be the direct-coupled type.

f. Where multiple electric actuators operate from a common signal, the actuators shall provide an output signal identical to its input signal to the additional devices.

g. Valve Actuators: Valve actuators shall provide shut-off pressures and torques for the corresponding flow rates and system pressures.

h. Damper Actuators: Damper actuators shall provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque shall be at least 6 inch-pounds per 1 square foot of damper area for opposed blade dampers and 9 inch-pounds per 1 square foot of damper area for parallel blade dampers.

i. Positive Positioning Devices: Positive positioning devices shall be a pneumatic relay with a mechanical position feedback mechanism and an adjustable operating range and starting point.

16. Humidity transmitter shall be two-wire, 4-20 ma output sensing device using bulk polymer resistance sensor technology.

a. Transmitters shall meet the following specifications:

1) Accuracy: $\pm$2 percent RH ($\pm$2 percent RH is available)

2) Span: 15 percent to 95 percent RH

3) Operating Temperature Range: 30˚F to 120˚F minimum

4) Temperature Affect: $\pm$0.06 percent per degree centigrade change in ambient temperature

5) Manufacturer: Veris HT Series

b. Where temperature and humidity are being measured in the same room, the temperature and humidity transmitter shall be mounted on a common mounting bracket and covered with a common cover. Transmitter shall be Veris HT Series.

c. The humidity transmitter shall not be damaged when moisture condenser on the sensor itself.

17. Accelerometer: this sensor shall be piezoelectric type and shall be used for measuring vibration on equipment. The vibration shall be measured as analog quantity. Pre-set vibration switches shall not be acceptable.

18. Occupancy sensors: Sensors are provided by the electrical contractor.

19. DDC natural gas meter

a. Provide a separate insertion type gas meter in the gas main that goes to the gas fired hot water heaters.

b. Provide all components required to allow the BAS to monitor and record the quantity of natural gas used by the domestic and HVAC hot water boilers.

c. Meter shall be Kurz series 454FTB insertion meter.

20. BTU Meter

a. Provide a microprocessor based instrument designed to provide full energy, flow and temperature data.

b. The corresponding flow meter, temperature sensors, and other relative components shall be provided by the same company that provides the BTU meter for a complete package.

c. The BTU unit shall have a serial connection with the BAS using the BACnet protocol. All points from the meter shall be accessible through the BAS.

d. Meter shall be custom calibrated and matched to an accuracy better than ±0.15°F from 32-200°F.

e. Meter shall be Onicon System 10 series or equivalent.

F. Grade C Instrumentation. This is of the high quality commercial instrumentation with accuracies typically in the 1.0 percent to 5.0 percent range. This Grade C Instrumentation shall be used for unit heaters, cabinet heaters, and similar equipment serving mechanical equipment rooms, stairwells, etc.

1. Space Temperature Transducers shall be factory calibrated, field calibration or adjustment is not permitted**.** The transducers shall be protected against damage from reverse polarity and line transients sensors. The sensors shall meet the following specifications:

   a. Accuracy: ±2.0 percent of span

   b. Stability: ±0.01 percent of span/degree C

   c. Linearity: ±0.05 percent of span

   d. Span: 50˚F minimum

   e. Temperature Limits Ambient: 32˚F to 122˚F

2. Duct and Liquid Temperature Transducers shall be factory calibrated, field calibration or adjustment is not permitted. The transmitter tranducers shall be protected against damage from reverse polarity and line transients. The sensor shall meet the following specifications. Transducers used in liquid service shall be supplied with three (3) inch lagging extension stainless wells.

   a. Accuracy: ±1.0 percent of span

   b. Stability: ±0.01 percent of span/degree C

   c. Linearity: ±0.05 percent of span

   d. Span: 50˚F minimum

   e. Temperature Limits Ambient: 32˚F to 122˚F

3. Differential Temperature Transmitters shall be factory calibrated, field calibration or adjustment is not permitted. The transmitter shall be protected against damage from reverse polarity and line transients. The transmitter shall meet the following specifications:

   a. Accuracy: ±2.0 percent of span

   b. Stability: ±0.01 percent of span/degree C

   c. Linearity: ±0.05 percent of span

   d. Span: 25˚F maximum

   e. Temperature Limits Ambient: 32˚F to 122˚F

4. Static Pressure Transducer: The sensor is constructed on a single printed circuit card. The input ranges are switch-selectable, offering both unidirectional and bi-directional pressure sensing settings.

a. Accuracy: ±2.0 percent of span

b. Long-Term Stability: ±1 percent of span per year

c. Span: 0.25 inch wc minimum to 10 inch wc maximum span

d. Overpressure: 25 inch ws without damage

e. Power Supply: 24 to 40 volts DC at 30 ma

f. Output: 1 to 5 volts DC, 0-10 VDC, 4-20 MA

5. Differential Pressure Transducer: the sensor is constructed on a single printed circuit card. The input ranges are switch-selectable, offering both unidirectional and bi-directional pressure sensing settings.

a. Accuracy: ±2.0 percent of span

b. Long-Term Stability: ±1 percent of span per year

c. Span: 0.25 inch wc minimum to 10 inch wc maximum span

d. Overpressure: 25 inch ws without damage

e. Power Supply: 24 to 40 volts DC at 30 ma

f. Output: 1 to 5 volts DC, 0-10 VDC, 4-20 MA

6. Liquid Flow Meter: Flow transmitters shall be of a two-wire 4-20 ma type, operating on a vortex shedding principle and provide a current signal linear with flow. Transmitters shall be factory wet calibrated, field calibration or adjustment is not permitted. The transmitter shall be protected against damage from reverse polarity and line transients. The transmitter shall meet the following specifications:

a. Accuracy: ±5.0 percent of rate

b. Repeatability: 0.2 percent of span

c. Rangeability: 20:1

d. Temperature Limits: -40˚C to +215˚C

e. Ambient: -40˚C to +65˚C

7. Space Static Pressure Probe shall allow accurate space static measurement in the presence of radial air velocity sources. The probe shall be specifically designed for ceiling mounting.

a. Accuracy: 1 percent of reading @ 1000 FPM Radial

b. Weight: Velocity

c. Finish: 8 oz. Brushed Anodized Aluminum

8. Air Flow Measurement Stations shall be complete with flow straightening section, multiple self-averaging velocity and static measurement probes, housed in a flanged duct section.

a. Accuracy: ±2 percent

b. Repeatability: ±0.2 percent

c. Temperature: -200˚F to 420˚F

9. Electronic Air Flow Transducers: Transducers are electronic monitors of air mass flow in ducts. They measure mass flow directly, monitor low flows down to 0-100 SFPM, and do not need pneumatic hook-ups, square-root extractors or temperature and pressure corrections.

a. Accuracy: 3 percent FS over 32˚F to 122˚F

b. Repeatability: 1 percent FS

c. Response Time: 300 ms (to 63 percent of final flow)

d. Range: 0 to 200 FPM - 0 to 2000 FPM

e. Temperature: -4˚F to 212˚F

f. Output Signal: 100 to 300 ma

g. Input Power: 24 volts DC

10. Current to Pressure Transducer (I/P) shall be of industrial quality and capacity. Motor driven PRVs, switching solenoid valves, or position sensitive devices are not acceptable. The current to pressure transducer shall meet the following specifications:

a. Supply Pressure: 25 psig $\pm$2 psig

b. Linearity: $\pm$2.0 percent of span

c. Span: 3-15 psig

d. Flow Rate: 4.5 SCFM @ 25 psig supply pressure

e. Air Consumption: 0.25 SCFM

11. Reheat Valve:

a. Valves up to and including 1-1/4 inch shall have union connections. Valves 1-1/2 inch shall have screwed ends. All valves 2 inches and less in size shall be of high grade bronze. All valves 2-1/2 inches and larger shall have flanged ends, cast iron bodies and positive positioners.

b. All 2-way reheat control valves shall be PICCV characteristic ball valves by Belimo with corresponding actuator.

c. All 3--way reheat control valves shall be CCV characteristic ball valves by Belimo with corresponding actuator.

12. Humidity transmitter shall be two-wire, 4-20 ma output sensing device using bulk polymer resistance sensor technology.

a. Transmitters shall meet the following specifications:

1) Accuracy: $\pm$2 percent RH

2) Span: 15 percent to 95 percent RH

3) Operating Temperature Range: 30˚F to 120˚F minimum

4) Temperature Affect: $\pm$0.06 percent per degree centigrade change in ambient temperature

b. Where temperature and humidity are being measured in the same room, the temperature and humidity transmitter shall be mounted on a common mounting bracket and covered with a common cover. Transmitter shall be as manufactured by Veris or approved equal.

c. The humidity transmitter shall not be damaged when moisture condenser on the sensor itself.

G. Binary Sensing Devices for Air Systems and Electric Control

1. General

a. Output signals from binary devices shall be SPST (N.O.) SPST (N.C.), SPDT, DPST (N.O.), DPST (N.C.) or DPDT signals as required by the application. All

contacts shall be rated for a minimum of 7.4 amps at 120 volts AC inductive and 3.7 amps at 240 volts AC inductive or greater if required by the application.

b. All contact ratings and duties shall be rated in accordance with NEMA ICS1.

2. Temperature Switches

a. Temperature switches for duct application shall be remote bulb thermostats with an adjustable setpoint range of 20˚F to 120˚F. The changeover differential shall be adjustable between 6˚F and 45˚F.

b. Temperature switches for room temperature control shall include line voltage room thermostats. These devices shall be SPST or SPDT devices with a range of 40˚F to 90˚F and a changeover differential of 1.8˚F to 3.5˚F. These devices shall be suitable for heating or cooling duty for such applications as operating unit heaters or ventilation exhaust fans.

c. Low-voltage room thermostats shall be two-position temperature regulating instruments with anticipator circuits designed for close control of heating and/or cooling systems. These devices shall be suitable for 10 amps at 120 volts AC inductive. These devices shall have range of 45˚F to 90˚F and a changeover differential of 0.5˚F for heating and 1.5˚F for cooling. Room thermostats shall have an on-off-automatic switch to control the fan and heating-off-cooling switch to control functions. The thermostats shall have automatic changeover from heating to cooling and vice versa.

3. Freeze protection thermostats shall be snap-acting manual reset electrical devices which will contain a DPST switch. Freeze protection thermostats shall have a 20 foot capillary element, any portion of which, sensing a low temperature, shall activate the control to stop the supply fan. Sufficient freeze protection thermostats will be furnished to adequately protect the entire cooling coil. Thermostat range shall be adjustable 30˚F to 55˚F minimum.

a. Provide one freezestat for each 80 square feet of coil surface area.

b. The main set of contacts shall be wired to the fan starter; the auxiliary set shall be wired to the DDC system.

4. Pressure switches and differential pressure switches shall be diaphragm operated SPDT snap switches. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure at which the electric switch will be actuated. Switches shall be suitable for a minimum of 25 inches w.g. pressure or differential pressure without damage.

a. Switch ranges shall be selected to fall within the switch scale based on 80 percent of the "measured" devices rated pressure or differential pressure.

b. Switches shall be Dwyer Series 1910, Cleveland AFS 460 or approved equal.

5. No sail switches shall be used.

6. Vibration switches shall be acceleration sensitive devices that measure the total peak vibratory shock. The device shall provide electric switch contact closure for shutdown of fans, pumps, or compressors. The device shall be DPDT for direct wiring to the equipment and to the DDC system. The setpoint shall be field adjustable between 0 and 4.5 Gs in a frequency range of 0 to 50 Hz. The device shall be manual reset.

a. The main set of contacts shall be wired directly to the fan, pump, or compressor starter; the auxiliary set shall be wired to the DDC system.

b. Devices shall be Vibra-Alert Model 5173 or 5175 vibration switches or approved equal.

7. Damper End Switches

a. Damper end switches for new smoke dampers and for new combination fire/smoke dampers shall be furnished with each new damper provided by the HVAC Contractor.

b. Damper end switches for existing smoke dampers and for existing fire and smoke dampers shall be provided by the DDC System Supplier and shall be the same switches which would be furnished as the standard offering of the "existing" damper manufacturer.

c. Damper end switches used for outdoor air, return air, and relief air dampers in engineered smoke control systems shall be provided by the DDC System Supplier.

d. Damper end switches, unless otherwise specified, shall be low operating torque spring return NEMA 13 oil tight limit switches with "cat whisker" operating lever. End switch shall be provided complete with rigid mounting bracket for attaching switch to a "fixed" surface and a rigid for attachment to the movable portion of the damper as required. Damper end switch shall be Allen Bradley Catalog #302T-CW or approved equal.

8. Jumbo pushbutton for labs shall be NEMA 13 oil tight mushroom head momentary contact spring return pushbutton units complete with legend plate and flush wall plate and guard. Pushbutton shall have one N.O. and one N.C. set of contacts.

a. Legend plate shall read, "Emergency."

b. Pushbuttons shall be Allen Bradley Catalog #800H-DGB (red) with #800T-N151 guard or approved equal.

9. Other control devices such as manually operated selector switches and pushbuttons shall be industrial quality switches, selected for the specific application. Switches shall be a minimum of NEMA 13 oil tight.

a. All switches shall be the standard products of Allen Bradley, Cutler Hammer, Westinghouse, or approved equal.

H. Binary Sensing Devices for Water Systems

1. General

a. Output signals from binary devices shall be SPST (N.O.), SPST (N.C.), SPDT, DPST (N.O.), DPST (N.C.), or DPDT signals as required by the application. All contacts shall be rated for a minimum of 7.4 amps at 120 volt AC inductive and 3.7 amps at 240 volts AC inductive or greater if required by the application.

b. All contact ratings and duties shall be rated in accordance with NEMA ICS1.

2. Temperature Switches

a. Temperature switches (aquastats) shall be surface mounted electric thermostats designed for mounting directly onto pipes. These devices shall be SPDT devices with a range of 50˚F to 150□F and a changeover differential of approximately 10˚F. These devices shall be suitable for such applications as operating unit heaters.

b. Remote bulb temperature switches shall be electric thermostats used where remote or immersion sensing is required. These devices shall be SPDT devices with ranges of 20˚F to 120˚F or 100˚F to 240˚F and an adjustable changeover differential of between 6˚F and 45˚F.

c. Immersion sensing elements shall be provided complete with thermometer wells.

3. Pressure switches shall be SPST (N.O.) type operated by a stainless steel bourdon tube actuating a mercury switch. Switch shall be rated for a minimum of 300 (150) psig operating pressure with a minimum adjustable operating setpoint of 10 psig. Deadband shall be adjustable up to 100 percent of the switch range. Switch shall have a visible calibrated dial and two visible pointers indicating setpoint and reset point and shall have visible on/off indication.

   a. Pressure switches shall be Mercoid Series DA-41 or approved equal.

   b. Pressure switches shall be provided complete with snubber.

4. Differential pressure switches shall be SPST (N.O.) type operated by two opposing double bellows actuating a mechanical linkage. Switch shall be rated for a minimum of 300 (150) psig operating pressure with a minimum adjustable operating differential setpoint range of 0 to 30 (20) psig; deadband shall be adjustable 6 to 30 (20) psig. Switch shall have a visible calibrated dial and two visible pointers indicating setpoint and reset points.

   a. Differential switches shall be Mercoid Series DP-7043-153 or approved equal.

   b. Each pressure sensor leg shall be provided complete with snubber.

5. Paddle type flow switches shall be SPDT or DPDT switches as required by the application and shall be constructed with stainless steel parts being in contact with the water. The switch shall be suitable for installation in a female NPT pipe opening. The switch shall be rated for a minimum of 300 (150) psig operating pressure. The operating flow rate (flow - no flow) shall be adjustable.

   a. Flow switch shall be McDonnell Miller Series FS7-4 (FS4-35) or approved equal.

   b. Time delay relays shall be provided for switches which operate directly with the pump starter.

6. Level Switches

   a. Float operated level switches shall be float actuated level switches for turning pumps on and off and opening and closing valves to maintain level. The device shall also alarm and cut-out on low level. The device shall be rated for minimum 150 psig operating pressure and shall be complete with sight glass. Float switch shall be McDonnell Miller No. 157 Pump Controller/Low Water Cut-Off or approved equal.

   b. Float operated level switches for tank level detection and control shall be vertical displacer type with up to four (4) displacers and three (3) SPST switches. The number of displacers and switches shall be determined by the application. Displacers shall be porcelain or stainless steel. Displacer housing shall be supported on a cast iron flange. Switch shall be provided with a vented stilling chamber. Switch shall be McDonnell Miller Model DFC with mercury switches or approved equal.

   c. Probe actuated level switches shall be single or multiple conductance actuated controls which utilize electrodes and the conductivity of the fluid to sense liquid level. The number of probes (up to four) and switches shall be determined by the application. The control housing shall be suitable for inserting in vessels with pressures up to 250 psig. Probe shall be suitable for 120 volt pilot voltage. The switch shall be provided with a vented stilling chamber. Switch shall be McDonnell Miller Model PCH-G-A or approved equal.

7. Current switches for pumps shall be designed to mount in the starter enclosure on a power lead of the device to be monitored and energize a solid-state switch when the current level rises above the trip point. The trip point shall be easily knob adjusted from

the front of the switch and the trip point shall have a differential of ±5 percent of full range. The switch shall be powered from the starter control transformer and shall have overcurrent protection to 200 percent of the upper range limit. The output shall be a SPST (N.O.) switch, rated at 120 volts AC.

a. Current switches shall be Cymatics Model 850 or approved equal.

8. Reed relays shall be used for conversion of a single pulsed input to a multiple pulse input. This would happen where a single meter with a single pulse output used in a pre-packaged control process would be monitored by the DDC system; i.e., to determine cooling tower water consumption from the chemical feed system water meter. The purpose is to convert one "long duration pulse" into several "short duration pulses."

a. Outputs from relays shall be multiple SPST (N.O.) signals as required by the sequence of operation. All contacts shall be rated for low-energy switching at a maximum 150 volts AC, 500 ma, 25 VA maximum.

b. All contacts ratings shall be rated in accordance with ICS1.

c. Relay holding coils shall be rated for available input current and voltage and for continuous duty if necessary. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

I. Other Output Devices

1. Control Relays: All control relays interfacing to AC circuits shall be solid state with zero crossing, capable of handling 240V AC at 3A.

2. Electric Solenoid Operated Pneumatic (EP) Valve: EP valves shall have three port operation: common, normally open, and normally closed. EP valves shall have an outer cast aluminum body with internal parts constructed of brass, bronze, or stainless steel. The air connection shall be a 3/8 inch NPT threaded connections. EP valves shall be rated for 50 psig when used in control system operation at 25 psig or less, or rated at 150 psig when used in control system operation from 25 to 100 psig. EP coils shall be equipped with transient suppression to limit transients to 150 percent of rated voltage. EP valve operation shall be rated for a minimum of 220˚F.

3. Single Input Control Point Adjustment (CPA) Controller: Single input CPA controllers shall permit changing of control points remotely by varying the CPA port value. CPA shall be plus or minus 10 percent of primary sensor span. Controllers shall operate from electronic or pneumatic sensors as shown. Controllers shall be complete with adjustable setpoint, adjustable gain (proportional band) and shall be field selectable for direct or reverse action. Pneumatic units provided shall be constructed to withstand a maximum pressure of 25 psig. All controller inputs and outputs shall be provided with internal or external gauges for calibration on input and output signals.

4. Dual Input Controller: Dual input controllers shall permit changing of control points remotely by varying the second port input value. Controllers shall operate from electronic or pneumatic sensors as shown. Controllers shall be complete with adjustable setpoint, adjustable gain (proportional band), adjustable authority, and shall be field selectable for direct or reverse action. Authority effect of secondary sensor on setpoint shall be adjustable from 33 to 100 percent of primary sensor span. Pneumatic units shall be constructed to withstand a maximum pressure of 25 psig. All controller inputs and outputs shall be provided with internal or external gauges for calibration of input and output signals.

5. Position Sensors

a. End (Limit) Switch: Limit switches shall be of the enclosed or sealed type as required for the application. Contacts shall be snap-action Form C rated for the application.

b. Potentiometers: Potentiometers may be either rotary or linear, depending on the application of each position indicator. Position potentiometers shall have a linearity of plus or minus 5 percent and shall indicate position on a percent open basis.

J. Analog Output Devices

1. General

a. The analog outputs from the DCPs shall generally be a 4-20 ma or 0-10 volt signal which will be used either to control the setpoint of "external" devices as 4-20 ma input (i.e., a variable frequency drive) or to control a pneumatic output device (i.e., a valve or damper).

b. All control signals to "external" devices shall be protected from surges induced on the control wiring on each end. These "inputs" and outputs shall be tested in both normal mode and common mode using the following waveforms:

1) A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

2) An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

c. All control signals to pneumatic control devices shall have the signal converted from (4-20 ma or 0-10 VDC to pneumatic via a current to pneumatic (I/P) or voltage to pneumatic (E/P) transducer.

2. Pneumatic (I/P, E/P) Transducers

a. Transducers shall meet the following specifications:

1) Supply pressure: 25 psig $\pm$ 2 psig

2) Signal: 4-20 ma or 0-10 v

3) Output pressure: 3-15 psig

4) Linearity: $\pm$1.0 percent of span at 25 psig supply

5) Flow Rate, Midrange: 4.5 SCFM at 25 psig

6) Air Consumption, Midrange: 0.1 SCFM

7) Supply Pressure sensitivity, Midrange: $\pm$1 percent of span per psig

8) Minimum Overpressurization without Damage: 30 psig

b. Each transducer output signal shall be provided with a minimum 1 inch diameter pressure gauge or LCD display.

c. Outputs from transducers shall be used to control valves, control dampers, or to reset pneumatic control setpoints.

K. Electrically Actuated Dampers and Valves

1. When called for or allowed in the specification, electronically actuated valves and dampers shall be provided in lieu of pneumatically actuated devices.

2. These actuators shall be provided in adequate size and quantity to properly position each automatic control device.

3. Refer to pneumatically actuated dampers and valves in the specification for further requirements pertaining to valve and dampers.

4. Electronic Actuators - General

a. Electronic actuators shall be selected for valves and dampers based on the torque and thrust requirements of the device to be controlled.

b. Actuators for valves and dampers shall be designed to operate in environments between 35˚F and 140˚F. Actuators for outdoor air dampers shall be designed to operate in environments between -4˚F and 122˚F.

c. Actuators shall have a minimum five-year replacement warranty.

d. All valve and terminal box actuators shall be shipped to the valve and terminal box manufacturer for mounting. Mounting costs shall be borne by the DDC System Supplier.

e. Electronic actuators shall be permitted for all applications except where noted.

5. Electronic Damper Actuators

a. Electronic damper actuators for smoke dampers shall be standard electronic actuator. These actuators shall meet the following requirements:

1) Full close to full open stroke time shall be five minutes maximum.

2) Modulating dampers shall modulate or position itself using an electronic motor and, in conjunction with damper arm as required, shall create a minimum of 133 inch-pounds of torque. Multiple actuators shall be used where higher torque requirements are required.

3) Modulating damper positioning shall be controlled using a controlled output signal or the damper actuator shall be provided with positive positioning feedback.

4) Open close damper positioning shall be controlled using an on/off closure and shall be provided with end switches.

5) Upon power loss, the damper actuator shall "spring return" to a normally open or normally closed position as specified in the control sequences.

6) Damper actuator shall be provided with a visual damper position indication on the actuator body.

6. Electronic VAV Box damper and Reheat coil valve actuators:

a. Actuators

1) Electronic dampers actuators for equipment shall be electronic actuator. These actuators shall meet the following requirements.

2) Full open close stroke time shall be120 seconds or less

3) Actuators shall be Underwriters Laboratories approved under standard 873

4) Actuators used near outdoor air streams shall have NEMA type 2 housing for water and moisture

5) Actuators shall be direct couples to the valve

6) Actuators shall be applied as per manufacturer’s specifications

7) The valve Actuators shall be capable of providing the minimum torque required for proper valve close-off pressure for the required application.

8) Actuators shall have current limiting circuitry or overload protection

9) Applications that require fail safe operation of the valve assembly shall use actuators with mechanical springs.

10) Interior valve shall fail to last position.

11) All proportional valves shall be positive positioning and respond to a 2-10 VDC or 4-20 ma signal. Positioning shall be within 0.5 percent of stroke. The actuator shall provide positive positioning feedback. Floating point actuators shall not be allowed.

12) Actuators shall operate on 24 volts AC power.

13) Manufacturer shall provide a 5 year unconditional warranty.

b. Valves

1) Valves 1/2" through 2" shall be forged brass body with nickel plating, NPT screw type. The operating temperature range shall be 0 Deg. to 212 Deg. F.

2) The valves shall have an ISO 4 bolt flange for mounting actuators in any orientation. A non-metallic thermal isolation adaptor shall separate the flange from the actuator with high temperature material rated for continual use at greater than the application temperature. Valves assemblies without thermal isolation shall not be acceptable.

3) Valves up to and including 1-1/4 inch shall have union connections. Valves 1-1/2 inch shall have screwed ends.

4) The isolation adaptors shall provide stable direct coupled mechanical connection between the valve body and actuator and prevent lateral or rotational forces from affecting the stem and its packing O-rings.

5) All control ball valves shall be furnished with a stainless steel ball and stem and fiberglass reinforced Teflon seats and seals. The valves shall have a blow out proof stem design. Each valve shall be tested by the valve manufacturer.

6) Flow type for modulating two way and three way valves shall be equal percentage. All control valves shall have a flow characterizing disc in the inlet of the valve to provide the equal percentage control port. They shall have a modified linear bypass port which will yield 70% of the flow of the A port.

7) Manufacturers shall provide a two year unconditional warranty from the date of acceptance.

8) 2-way valves shall be Belimo PICCV valves with a Belimo electric actuator rated for the application.

9) 3-way valves shall be Belimo CCV valves with a Belimo electric actuator rated for the application.

7. Isolation and Modulating Water Control Valves:

a. AHU Chilled Water Coil Control Valves

1) Prove Belimo electronic actuator sized and rated for the application.

2) Valves shall be Delta P valves by Flow Control Industries (FCI).

b. Other Control Valves over 2-1/2"

1) Valves shall be high-performance Butterfly valves by Belimo.

2) Valves shall meet the performance requirements in Specification Section 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

3) Prove Belimo electronic actuator sized and rated for the application. The only exception is as noted on drawing M801 which shall be pneumatic actuated valves.

c. Other Modulating Control Valves 2-1/2" or smaller

1) Valves shall be as specified above in section 3.13.J.6.b

2) Prove Belimo electronic actuator sized and rated for the application.

d. Other Two Position Control Valves 2-1/2" or smaller

1) Valves shall ball valves by Belimo that meet the performance requirements in Specification Section 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

2) Prove Belimo electronic actuator sized and rated for the application.

L. Miscellaneous Electrical Equipment

1. Relays

a. Socket Mounted Relays - 5 Amp Contacts: Relays shall be three pole double throw socket mounted devices with an octal pin type or blade type mounting arrangement. Contacts shall be rated for 5 amps at 120 volts AC. Coil voltage shall be as specified on the drawings or equipment lists and shall draw no more than 2.5 VA. Relays shall be provided with mounting sockets with screw type terminals and shall be suitable for mounting on a standard DIN EN 50022 mounting rail. Relays shall be provided with a manual test button for check-out and troubleshooting purposes. Acceptable devices and manufacturers are as follows:

MANUFACTURER	MODEL	COMMENTS
Potter & Brumfield	KUP14A25 relay	
Idec	RR3PA-UC relay	
	RR3B-UC relay	
Omniron	MJ3PI-UA relay	

b. Multi-Function Programmable Time Delay Relay: Time delay relay shall be capable of performing as a delay on make, delay on break, or interval timer depending on DIP switch programming or terminal jumpering. Relay time delay range shall be from 0.5 seconds minimum to 2 hours or more. Relay output shall be at least 1 set of single pole double throw contacts rated for at least 5 amps at 120 volts AC. Mounting shall be in a screw terminal type socket provided with the relay. The socket shall be suitable for mounting on a standard DIN EN 50022 mounting rail. Relay power supply voltage shall be as specified on the drawings or parts list or required for proper operation. Acceptable manufacturers and models are as follows:

MANUFACTURER	MODEL	COMMENTS
Automatic Timing & Controls Co.	328A200 relay	
Barber Colman	P-186-8-2 relay	
Guardian	PET 1481 relay	
Syrelec	LR2 Series	

c. Cube Type On-Delay Relay: Relays shall be series wired on delay relays with the voltage and time delay ratings indicated on the drawings and parts lists.

Relays shall be arranged to be wired in series with the load they serve. Adjustable time delay range, where specified, shall be provide with potentiometer wired to auxiliary terminals at the relay or programmed by DIP switches mounted at the relay. Terminals shall be screw type or quick connect spade type. Where adjustable delay ranges are specified, the relay shall be provided with all necessary accessories required to provide the adjustable range. Relays shall be capable of switching loads up to 1 amp at the input voltage specified. Acceptable manufacturers and models are as indicated below:

MANUFACTURER	MODEL	COMMENTS
National Controls Corporation	Q1 series	
Artisan	438U or 438USA or 438UP or 438 or 438AP	
Idec	RTS-MN	
Syracuse	SMPA or SMPB	

d. Cube Type Off-Delay Relay: Relays shall be off delay relays with the voltage and time delay ratings indicated on the drawings and parts lists. Timing shall be initiated by the opening of an isolated external contact. Adjustable time delay range, where specified, shall be provided with a potentiometer wired to auxiliary terminals at the relay or programmed by DIP switches mounted at the relay. Terminals shall be screw type or quick connect spade type. Where adjustable delay ranges are specified, the relay shall be provided with all necessary accessories required to provide the adjustable range. Relays shall be capable of switching loads up to 1 amp at the input voltage specified.

1) Acceptable manufacturers and models are as indicated below:

MANUFACTURER	MODEL	COMMENTS
National Controls Corporation	Q3 series	
Artisan	4710	
Syracuse	SBPA	

2. Switches, Potentiometers, and Lights

a. Multi-Pole, Multi-Step Rotary Switch: Switches shall be panel cover mounted switches with operator and numbered legend panels. Poles and steps shall be as required by the application or as indicated on the drawings. Contacts shall be rated for 10 amps at 120 volts AC. Provide a placard for each switch to be mounted with the switch indicating the function of each position. Acceptable manufacturers and models are as follows:

MANUFACTURER	MODEL	COMMENTS
Entrelec	VY10 Family	

b. Push to Test Pilot Lights: Pilot lights shall be suitable for cover mounting in control panels and shall be rated for the voltage associated with the application. Lens colors shall be as specified or as required by the application. Lamps and holders shall be the push-to-test type with the words "Push To Test" or "Press To Test" clearly engraved or cast into the lens cap. Lamps shall be provided with legend plates indicating the function associated with illumination of the lamp.

c. Momentary Contact Push-Buttons: Switches to be panel mounted single pole single throw normally off momentary on rated for a minimum of 3 amps at 120 volts AC. Buttons shall be color coded as indicated on the drawings or parts list. Switches to be supplied with all accessories required for panel mounting.

Switches to have screw type terminals. The following devices and manufacturers are acceptable:

MANUFACTURER	MODEL	COMMENTS
Idec	TWTD Series	
	TW Series	
Allen Bradley	800MS Series	
	800MR Series	
Rafix	22/30 Series	

d. Toggle Switches - Single Pole Single Throw: Switches to be panel mounted single pole single throw two-position switches with both positions maintained. Contacts to be rated for a minimum of 15 amps at 120 volts AC. Switches to be supplied with all accessories required for panel mounting. Switches to have screw type terminals. The following devices and manufacturers are acceptable:

MANUFACTURER	MODEL	COMMENTS
Idec	TWTD Series	
	TW Series	
Allen Bradley	800MS Series	
	800MR Series	
Rafix	22/30 Series	

e. Toggle Switches - Single Pole Double Throw: Switches to be panel mounted single pole double throw three position (center off) switches with all positions at 120 volts AC. Switches to be supplied with all accessories required for panel mounting. Switches to have screw type terminals. The following devices and manufacturers are acceptable:

MANUFACTURER	MODEL	COMMENTS
Idec	TWTD Series	
	TW Series	
Allen Bradley	800MS Series	
	800MR Series	
Rafix	22/30 Series	

f. Panel Cover Mounted 10 Turn Clock Face Potentiometers: Potentiometers shall be panel cover mounted devices with 10 turn clock face dials and shall be rated for the voltage and current of the circuit they are serving. Acceptable devices and manufacturers are as follows:

MANUFACTURER	MODEL	COMMENTS
Bourns	3600S-1	
Bourns	3640S-1	

g. Trimmer Potentiometer: Trimmer potentiometers shall be internally mounted at terminal strips in control panels and shall have values as required by the application. Pots shall have a screwdriver type multi-turn adjustment accessible with the device in its normal mounted position. Mounting terminals shall be of the sliding link type to allow the device to be isolated from the circuit it serves for set up. Devices shall be rated for the voltage and current of the circuit they are installed in. Acceptable manufacturers and models are as follows:

MANUFACTURER	MODEL	COMMENTS
Bourns	20	
	3006	
	3009	
	3099P	

3. Temperature and Pressure Control Switches

a. Two-Position Electric Thermostat: Thermostats shall be snap-acting type thermostats with SPDT contacts rated for a minimum of 1.5 amps inductive at 120 volts AC. Cover arrangements shall be as specified or as directed by the Engineer at the time of shop drawing review. Minimum setpoint range shall be 55˚ to 85˚. Acceptable manufacturers and models are as follows:

MANUFACTURER	MODEL	COMMENTS
Landis & Gyr Powers	ET-134 Series	
Honeywell	T651A	
White Rodgers	1A16-51	

b. Remote Bulb Thermostat - Single Pole Double Throw: Thermostats shall be thermally actuated single pole double throw switches with a field adjustable setpoint and differential. Differential range of adjustment shall be a minimum of 6 to 12˚F. Minimum setpoint range of adjustment shall be as indicated below. Switch contacts shall be rated for a minimum of 6 amps inductive load at 120 volts AC, 3 amps inductive load at 240 volts AC. Capillary length shall be a minimum of 6 feet. Where indicated, thermostats shall be supplied with two wells (one for calibration and one for bulb installation). Acceptable devices and manufacturers are as follows:

RANGE OF ADJUSTMENT DEGREES F	LANDIS & GYR
20 to 100	141-0520
100 to 240	141-0521

4. Current Operated Switches

a. General: Current operated switches shall be provided with additional relays as required to perform the indicated functions in the sequences of operation. In addition, contact resistance associated with solid state relays shall be taken into consideration and accounted for in the design of the circuits using solid state relays to prevent problems associated with voltage drops through closed switches and leakage currents through open switches.

b. Current Operated Switch - Low Range: Devices shall be capable of changing the state of an isolated dry contact or switch when a flow of current is sensed in the wire they are monitoring. The isolated output must be capable of switching up to 1 amp at 120 volts AC or DC minimum as required by the application. Trip points shall be adjustable from a minimum of 2 amps to a maximum of 15 amps. Devices shall be provided with all necessary mounting hardware. Acceptable manufacturers and models are as follows:

MANUFACTURER	MODEL	COMMENTS
Potter and Brumfield	SDAS-01 Series	With mounting socket
Neilsen – Kuljian	D-100AC	

c. Current Operated Switch - High Range: Devices shall be capable of changing the state of an isolated dry contact or switch when a flow of current is sensed in the wiring they are monitoring. The isolated output must be capable of switching up to 1 amp at 120 volts AC or DC minimum as required by the application. Trip points shall be adjustable from minimum of 15 amps to a maximum of 300 amps. Devices shall be provided with all necessary mounting hardware. Acceptable manufacturers and models are as follows:

MANUFACTURER	MODEL	COMMENTS
Neilsen - Kuljian	D-100AC	

5. Pressure Switches

a. Differential Pressure Switches - Pump Proof of Operation: Switches shall be arranged to actuate a single pole double throw switch based on the difference between two pressures. Switches shall be bellows actuated. Switches shall be suitable for the working pressure of the system on which they are installed and shall have a minimum working pressure rating of 30 inches Hg vacuum to 100 psig. The setpoint shall be adjustable between 0 and 20 psig and the sensitivity shall be adjustable with a minimum setting of 1 psig. Switches shall be rated for a minimum of 5 amps at 120 volts AC. Enclosures shall be rated NEMA 1 and shall be provided with termination points for conduit and piping connections. Switches shall be Mercoid series DPA or approved equal by United Electric or Penn.

M. Miscellaneous Auxiliary Equipment

1. 24 Volt AC Control Power Transformers: Transformers shall be NEC Class 2 general purpose transformers with primary windings as required by the application and 24 volt AC secondary windings rated for 40 VA at 100 percent power factor. Transformers shall be installed in a suitable enclosure to prevent contact with the primary and/or secondary terminals when the cover is on the enclosure. Where transformers are provided for installation by others, the transformers shall be provided mounted in the enclosure. The mounting arrangement shall be such that the terminals are accessible for connection without removing the transformer from the enclosure.

a. Transformers shall be Honeywell AT72D series with suitable NEMA 1 enclosure or approved equal.

b. Similar transformers with higher VA ratings may be supplied but must be designed and installed to meet all requirements of NEC article 725 when used to serve Class 1, Class 2, or Class 3 low voltage circuits. Transformers shall be UL labeled.

c. Disconnecting Terminal Blocks: Terminal block shall be arranged to allow the entering conductor to be disconnected from the leaving conductor without lifting the conductor from its termination point. Disconnection shall be by screwdriver actuated sliding link, knife link, or plug switch. Terminals shall be rated for the voltage and current of the circuit they are contained in at a minimum. Termination points shall be arranged with test jacks to allow a meter to be connected without interfering with the operation of the disconnecting means. Terminals shall be suitable for and mounted on a standard DIN EN 50022 mounting rail. Acceptable models and manufacturers are as follows:

MANUFACTURER	MODEL	COMMENTS
Weidmuller	SAKC10	
Weidmuller	SAKT1	
Weidmuller	SAKT2	
Entrelec	4/6.SNT	
Entrelec	M6/8.ST2	
Phoenix	URTK/SP	
Phoenix	MTK-P/P	
Phoenix	UK4-T	

1) All of the above are with accessories as required for a complete assembly.

d. Fuse Holder Terminal Blocks: Terminal block shall be arranged to allow a fuse to be installed in the terminal strip between the entering and leaving wires of the termination point. Terminals shall be provided with LED, Neon, or mechanical fuse status indicators. Terminals shall be rated for the voltage and current of the

circuit they are contained in at a minimum. Terminals shall be suitable for and mounted on a standard DIN EN 50022 mounting rail. Acceptable models and manufacturers are as follows:

MANUFACTURER	MODEL	COMMENTS
Weidmuller	SAKS Series	
Entrelec	MB10/12 Series	
Phoenix	UK5 Series	

1) All of the above are with accessories as required for a complete assembly.

e. Component Holder Terminal: Terminals shall be arranged for mounting on standard DIN mounting rail and shall be set up to allow a discrete electronic component such as a load resistor or a trimmer pot to be mounted between the entering and leaving connection points. Jumpering shall be provided as required to interconnect to sliding link terminals if required by the application. Acceptable manufacturers and models are as follows:

MANUFACTURER	MODEL	COMMENTS
Curtis	CS Series	

1) With accessories as required for a complete assembly. Use for components with 14 and 16 pin DIP configurations.

Phoenix	UK4-TG/ST-BE	

2) With accessories as required for a complete assembly. Use for 2 and 4 lead components.

f. Feed Through Terminal Blocks: Feed through terminal blocks shall be compatible with the special purpose DIN rail system. Terminals shall be clamp type terminals suitable for solid or stranded wire from #18 AWG to #12 AWG (minimum range). Terminals shall be rated for the voltage and current at which they are applied and shall be provided with all necessary end caps, separators, etc., required for a complete installation.

g. Grounding Type Terminal: Terminals shall be color coded green and yellow and shall be compatible with the other specialty terminals specified above and shall mount on the same DIN rail system. Units shall be arranged so that the wiring connected to them is grounded to the enclosure via the mounting rail. Terminals shall be Phoenix USLKG, MSLKG, or equivalent as manufactured by Weidmuller or Entrelec. These terminals shall be provided for grounding cable shields at the points where the cables enter a control panel and terminate on the control panel terminal strip.

h. Resistor Style Terminal Block: Terminals shall be arranged for mounting on a standard DIN mounting rail and shall be provided with the appropriate resistor value and tolerance either factory or field installed. Terminals shall consist of a two level block with the upper terminals bussed together and the lower terminals bussed together. A resistor of the appropriate value and tolerance as require by the application and/or as indicated on the drawings shall be installed between the upper and lower busses. The terminals shall be applied where it is desired to pass a current loop through a series load resistor to generate a voltage drop for use by a control system or an indicator. Terminals shall be Allen Bradley 1492-UW5R, 1492-H2RA, B, or C, Phoenix UDK4-DUR, or equivalent models by Weidmuller or Entrelec.

3.14 ENCLOSURES - GENERAL

A. Enclosures shall conform to the requirements of NEMA for the type specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures installed indoors shall be NEMA 1 or as specified for special applications. All enclosures shall be lockable.

3.15 NAMEPLATES

A. Laminated plastic nameplates shall be provided for all I/O devices furnished. Each nameplate shall identify the function, such as "mixed air controller" or supply air temperature sensor." Laminated plastic shall be 0.125 inch thick, white with black center core. Nameplates shall be a minimum of 1 inch by 3 inches, with a minimum 0.25 inch high engraved block lettering. Nameplates for devices smaller than 1 inch by 3 inches shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the device. The name of the I/O device, as referenced in software, shall be placed on the nameplate.

B. Brass tags shall be minimum of 18 gauge polished brass, 1-1/2 inch diameter. Each tag shall include 0.25 inch high stamped black filled letters. Seton Type 250 BL or approved equal.

3.16 APPARATUS CONTROL PANELS

A. All electrical, electronic or pneumatic equipment including DCPs, DTCs and UCPs shall be installed in suitable panels or enclosures to protect the equipment from environment, dirt, rain, vandalism, and accidental damage.

B. Prewired apparatus control panels (ACPs) shall be provided for each HVAC unit and each system by the DDC System Supplier. ACPs shall include all electronic control chassis, relays, switches, transformers, time clocks, interval timers, pilot lights, setpoint adjustments, and temperature indication meters. All controls requiring adjustment shall be located in ACPs. The remote setting of the mixed air temperature and discharge temperature, regardless of whether by natural or mechanical cooling and the outdoor changeover shall be adjustable through a gradual switch at the face of the ACP.

C. Each ACP shall be provided with an isolation valve to disconnect the ACP from its main instrument air supply and a disconnect switch to isolate the line side of all electric circuits within the ACP.

D. The ACPs shall be fully enclosed cabinets, all-steel construction and shall meet the NEMA requirements for the location installed. All ACPs shall have hinged doors with a locking latch. ACP enclosures shall be NEMA 1 for indoor application. ACP enclosure for outdoor application shall be NEMA 4 or NEMA 3. ACP enclosures for the parking garage, dishwash room, and loading dock (indoor applications) shall be NEMA 4x (stainless steel or fiberglass).

E. All ACP locks shall be keyed alike. A means of storing control system instructions and drawings shall be provided inside cabinet for future reference. Cabinet and door shall be finished with two (2) coats of paint.

F. Instrumentation and control (I&C) diagrams for ACPs other than DCPs, DTCs and UCPs shall be provided. Drawings shall show complete I&C diagrams for all equipment furnished and shall be posted in the control panel. Drawings shall be furnished in permanently sealed laminated plastic. Condensed operating instructions explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system manually shall be prepared in typed form, laminated as specified for the I&C diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted and approved by the Architect/Engineer prior to posting. The instructions shall be posted before operation verification of the systems begins. Provide a mylar reproducible of each I&C diagram in addition to the posted laminated copy.

G. In DCPs and DTCs, a nameplate shall be provided inside the enclosure indicating the DDC System Supplier's name, project number, year built, panel number, serial number (if applicable) and all applicable field wiring and connection drawing numbers.

H. All ACPs shall be provided with laminated nameplates located on the exterior of the panel.

END OF PART 3

PART 4 - SYSTEM SOFTWARE

4.1 GENERAL SYSTEM SOFTWARE REQUIREMENTS

A. This part of the specification defines the minimum software requirements for the computer-based Direct Digital Control (DDC) System.

B. The general system software is for DCPs and for Operator's Consoles.

C. The software covered under this part of the specification includes DCP general software, Operator's Console software, general HVAC calculation software programs, general HVAC application programs and graphics.

D. Custom software is covered in Part 5 of these specifications under HVAC Control Sequences. Control Sequences for specific packages are covered in other parts for individual packages.

E. Communication Software for interfacing between the BAS System and The Laboratory system shall be fully BACnet compatible at the time of installation per Conformance Class 5 (as defined by the ANSI/ASHREA Standard 135-1995). Communication shall be capable via the Building TCP/IP Network.

F. Interoperability Requirements for interfacing into all third party systems both existing and new.

1. Third Party systems included but are not limited to:

a. Fire Alarm System via a serial BACnet interface to perform necessary sequences on drawings and within specifications. Coordinate with Division 28.

b. Electrical Metering (shall be part of contract except for providing the power monitor)

c. Variable Speed Drives (shall be part of this contract)

d. All other systems shown on drawings requiring serial interfaces.

2. The interface will be a seamless integration of all system points from the ATC to the campus EMS.

3. The interface will allow monitoring, reporting, alarming, and control of all system points.

4. Graphical user interface screens must be developed using these points.

5. The ATC vendor must provide any and all information, labor, programming and testing(i.e., points list, addresses, etc.) required to integrate the existing campus system.

6. The ATC vendor must provide all software and/or equipment required to connect into their system.

7. The University will provide the IP addresses and the range of the “BACnet Instance Numbers” for all systems.

8. All data shall be viewable from work consoles provided as well as other campus locations.

9. All data will be viewed in same format and function across all existing and new facilities.

10. Communication

a. All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to ASHRAE Standard 135-1995 or latest addition, BACnet, Conformance Class 5 as a minimum.

b. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

1) Connection of an operator interface device to any supervisory controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the campus network. Data, status information, etc. for all controllers shall be available for viewing and editing from any one supervisory controller on the internetwork.

2) All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.

G. System Functions For Interoperability

1. Regardless of the method selected to achieve interoperability, the DDC system should be expected to perform five basic tasks. These are:

a. **Data Exchange**: The exchange of data between two devices (e.g., PC workstations, building controllers, custom application controllers, or application specific controllers) is the most basic of interoperable functions. This function allows for the viewing (or reading) of data as well as making changes (or writing) of the data. For example:

1) A building controller has a temperature sensor that measures the outdoor air temperature. This is modeled as an analog input object. If we wanted to view the outdoor air temperature we could use a PC workstation and ask for (or read) the present value of the analog input named "outdoor air temperature.

2) In the same manner, we can change setpoints (write) to the values of analog and binary output objects and value objects. These basic functions can be used to share setpoints between controllers, provide data for graphics on a PC workstation, command the lights to come on, or sample data in a trend.

b. **Alarms and Events:** This function provides the operator with notification of non-normal conditions. A controller that has determined that an event has occurred is able to send an alarm message to a predetermined location. For Example:

1) A program that periodically compares the space temperature to a user-entered alarm limit in the building controller detects that the space temperature is too high. When the temperature exceeds that limit, the building controller generates an alarm and sends it to the PC workstation. At that workstation, an operator reads the alarm and acknowledges it.

c. **Schedules:** This set of functions allows for the editing and creation of schedules on a PC workstation that will be executed in a controller. For example:

1) The operator wants to change the stop time of the fan in the auditorium from 6:00 P.M. to 9:00 P.M. Using the scheduling function, the operator is able to load the schedule from the controller, change the stop time, and have the modified schedule at the controller.

d. **Trends:** The ability to sample, store and read trends is a valuable function. Trending is a tool for collecting data on system performance and energy usage. While trends are typically stored for archival purposes on a PC workstation, there are a number of reasons to sample them in a controller. This will reduce network traffic and also will allow for sampling of data if a PC is not continually connected to the controller.

e. **Network Management:** This final interoperability function provides the ability to manage the devices on the network. It includes tasks such as monitoring for a loss of communication and coordinating the time-settings of the clocks in each controller.

H. As a minimum the DDC contractor will be required to provide the following points in BACnet Conformance Class 5 format with all associated Bacnet services to the Ethernet LAN connection.

1. Analog Inputs
2. Analog Outputs
3. Analog Values
   a. Setpoints
   b. Limits
   c. Alarm Limits
   d. PID Tuning Constants
   e. Runtimes
   f. Time Delays
4. Binary Inputs
5. Binary Outputs
6. Binary Values
   a. Alarm States
   b. Enable / Disable
   c. Start / Stop
   d. Schedule Status
   e. Manual Commands

4.2 TYPICAL BIBB REQUIREMENTS FOR THIRD PARTY SYSTEMS

BIBB TYPE	BIBB TYPE	BACnet Service	Initiate	Execute
(Acronym)	(Verbose Description)			
NOTE: BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. The services are prescribed in terms of an 'A' and a 'B' device. Both of these devices are nodes on a BACnet inter-network. In most cases 'A' will act as the user of data (like a BAS Server) and the 'B' device will be the provider of this data (like a field control module or router).				
Data Sharing				
DS-RP-A	Data Sharing-ReadProperty-A	ReadProperty	X	
DS-RP-B	Data Sharing-ReadProperty-B	ReadProperty		X
DS-RPM-A	Data Sharing-ReadPropertyMultiple-A	ReadPropertyMultiple	X	
DS-RPM-B	Data Sharing-ReadPropertyMultiple-B	ReadPropertyMultiple		X
DS-RPC-A	Data Sharing-ReadPropertyConditional-A	ReadPropertyConditional		
DS-RPC-B	Data Sharing-ReadPropertyConditional-B	ReadPropertyConditional		

BIBB TYPE	BIBB TYPE	BACnet Service	Initiate	Execute
(Acronym)	(Verbose Description)			
DS-WP-A	Data Sharing-WriteProperty-A	WriteProperty	X	
DS-WP-B	Data Sharing-WriteProperty-B	WriteProperty		X
DS-WPM-A	Data Sharing-WritePropertyMultiple-A	WritePropertyMultiple	X	
DS-WPM-B	Data Sharing-WritePropertyMultiple-B	WritePropertyMultiple		X
DS-COV-A	Data Sharing-COV-A	SubscribeCOV		
		ConfirmedCOVNotification		
		UnconfirmedCOVNotification		
DS-COVU-A	Data Sharing-COV-Unsubscribed-A	UnconfirmedCOVNotification		X
DS-COVU-B	Data Sharing-COV-Unsubscribed-B	UnconfirmedCOVNotification	X	
Alarm & Event Management BIBB's				
AE-N-A	Alarm and Event-Notification-A	ConfirmedEventNotification		
		Unconfirmed EventNotification		
AE-N-B	Alarm and Event-Notification-B	ConfirmedEventNotification	X	
		Unconfirmed EventNotification	X	
AE-ACK-A	Alarm and Event-ACK-A	AcknowledgeAlarm	X	
AE-ACK-B	Alarm and Event-ACK-B	AcknowledgeAlarm		X
AE-ASUM-A	Alarm and Event-Summary-A	GetAlarmSummary		
AE-ASUM-B	Alarm and Event-Summary-B	GetAlarmSummary		X
AE-ESUM-A	Event-Summary-A	GetEnrollmentSummary		
AE-ESUM-B	Event-Summary-B	GetEnrollmentSummary		
SCHEDuling BIBB's				
SCHED-A	Scheduling – A			
	(must support DS-RP-A and DS-WP-A)			
SCHED-B	Scheduling – B			
	(must support DS-RP-B and DS-WP-B)			
	(must also have one calendar, schedule and command object)			
Trending BIBB's				
T-VMT-A	Trending – Viewing and Modifying Trends - A	ReadRange		
T-VMT-B	Tending – Viewing and Modifying Trends - B	ReadRange		X
T-ATR-A	Trending – Automated Trend Retrieval - A	ConfirmedEventNotification		
		ReadRange		
T-ATR-B	Trending – Automated Trend Retrieval - B	ConfirmedEventNotification		X
		ReadRange	X	
BIBB TYPE	BIBB TYPE	BACnet Service	Initiate	Execute
(Acronym)	(Verbose Description)			
Device Management BIBB's				
DM-DDB-a	Device Management – Dynamic Device Binding – A	Who-Is	X	
		I-Am		X
DM-DDB-B	Device Management – Dynamic Device Binding – B	Who-Is		X
		I-Am	X	

BIBB TYPE (Acronym)	BIBB TYPE (Verbose Description)	BACnet Service	Initiate	Execute
DM-DOB-A	Device Management – Dynamic Object Binding – A	Who-Has		
		I-Have		
DM-DOB-B	Device Management - Dynamic Object Binding – B	Who-Has		X
		I-Have	X	
DM-DCC-A	Device Management – DeviceCommunicationControl – A	DeviceCommunicationControl		
DM-DCC-B	Device Management – DeviceCommunicationControl – B	DeviceCommunicationControl		X
DM-PT-A	Device Management – PrivateTransfer – A	ConfirmedPrivateTransfer		
		UnconfirmedPrivateTransfer		
DM-PT-B	Device Management – PrivateTransfer - B	ConfirmedPrivateTransfer		
		UnconfirmedPrivateTransfer		
DM-TM-A	Device Management – Text Message – A	ConfirmedTestMessage		
		UnconfirmedTextMessage		
DM-TM-B	Device Management – Text Message – B	ConfirmedTextMessage		
		UnconfirmedTextMessage		
DM-TS-A	Device Management – TimeSynchronization -A	TimeSynchronization	X	
DM-TS-B	Device Management – TimeSynchronization - B	TimeSynchronization		
DM-UTC-A	Device Management – UTCTimeSynchronization - A	UTCTimeSynchronization		X
DM-UTC-B	Device Management – UTCTimeSynchronization – B	UTCTimeSynchronization		
DM-RD-A	Device Management – ReinitializeDevice – A	ReinitializeDevice		
DM-RD-B	Device Management – ReinitializeDevice – B	ReinitializeDevice		
DM-BR-A	Device Management – Backup and Restore – A	AtomicReadFile		
		AtomicWriteFile		
DM-BR-B	Device Management –Backup and Restore –B	AtomicReadFile		
		AtomicWriteFile		
DM-LM-A	Device Management – List Manipulation – A	AddListElement		
		RemoveListElement		
DM-LM-B	Device Management – List Manipulation – B	AddListElement		
		RemoveListElement		
DM-OCD-A	Device Management – Object Creation and Deletion – A	CreateObject		
		DeleteObject		
DM-OCD-B	Device Management – Object Creation and Deletion – B	CreateObject		
		DeleteObject		

BIBB TYPE	BIBB TYPE	BACnet Service	Initiate	Execute
(Acronym)	(Verbose Description)			
Network Management BIBB's		BACnet Network Layer Message		
NM-CE-A	Network Management – Connection Establishment – A	Establish-Connection-To-Network		
		Disconnect-Connection-To-Network		
NM-CE-B	Network Management – Connection Establishment – B	Establish-Connection-To-Network		
		Disconnect-Connection-To-Network		
NM-RC-A	Network Management – Router Configuration – A	Who-Is-Router-To-Network	X	
		I-Am-Router-To-Network		X
		I-Could-Be-Router-To-Network		X
		Initialize-Routing-Table	X	
		Initialize-Routing-Table-Ack		X
Virtual Terminal BIBB's		BACnet Service		
VT-A	Virtual Terminal – A	VT-Open		
		VT-Close		
		VT-Data		
VT-B	Virtual Terminal – B	VT-Open		
		VT-Close		
		VT-Data		

4.3 DCP GENERAL SOFTWARE

A. DCP Functions

1. The DDC System Supplier shall provide the necessary software to accomplish the following functions, fully implemented and operational, as a part of the DCP.

   a. Scanning of inputs.

   b. Control of outputs.

   c. Respond to all Operator's commands, whether at the local DCP or at a remotely located DCP.

   d. Maintain real time communication with all DCPs in the system.

   e. DCP diagnostics.

   f. Run all applications software and control sequences.

   g. Perform all mathematical functions and operations necessary for DDC system operation as specified.

   h. Commonly used functions and operations shall be assigned to function keys in order to facilitate system operator interface.

   i. Access to other system nodes shall be transparent to the user.

   j. The operator shall be able to perform the following functions:

      1) Automatically control the status of equipment, devices and systems and/or the value of their operating parameters.

      2) Display the status of equipment, devices, and systems and/or the value of their operating parameters.

3) Modify operating parameters and status.

4) Automatically trigger audible and visual indications of alarm(s).

5) Investigate and acknowledge alarm conditions.

6) Provide means to change, on-line, the control strategies or operational sequences.

2. Operating System: The DCP shall contain an operating system that controls and schedules DCP activities in real time. The DCP shall maintain a current point status of all points connected to that DCP. The execution of DCP application programs shall utilize the current status. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. The operating system shall provide communication to allow the loading of software and data files between the DCP and all management consoles in the system.

3. Monitoring and Control: Each command shall be executed by the DCP only after all constraint checks have been passed. As a minimum, each point shall have unique read and write access levels associated with them. Each logical point grouping shall be associated with a particular security zone used to allow or disallow access to logical point groupings. Each individual point shall be capable of being selectively overridden. Each analog point shall have high and low limits which constrain operator entry of values.

4. DCP Self-Test Diagnostics: Each DCP shall have self-test diagnostic routines implemented in firmware. The tests shall include routines that exercise memory.

5. DCP Performance Specifications: All Proportional Integral Derivative (PID) loops on the DCP shall execute periodically at a period not greater than 1.5 seconds. All PID constants shall be adjusted according to actual run time. The DCP shall provide user adjustable scan and control times in increments of not greater than 0.5 seconds. Each partition of the control algorithm on a DCP shall have its own pre-defined period of execution. This execution rate shall be user-modifiable on-line. Free running control algorithms are not acceptable.

6. DCP Start-up: The DCP shall have start-up software that causes automatic commencement of operation without human intervention. The start-up software shall initiate operation of self-test diagnostic routines. If the data base and applications software are not resident, the DCP shall attempt to communicate with any of the management consoles in the system to rectify the situation. If the real time cannot be read, the DCP shall attempt to communicate with other panels in the networked system to obtain the current real time.

7. DCP Operational Mode: The DCP shall perform all specified functions and application programs using data obtained from the DE and based upon the DCP real time clock function. All information required for operation, as specified for each day of the week and for a holiday schedule, shall be stored in the DCP data base and shall include inputs for operating for each mechanical system controlled by each DCP. The DCP shall answer requests for data communications from all other DCPs in the network and from all management consoles in the network, including the following:

   a. Execution of local (on this DCP) and remote (on any other DCP) operator initiated commands.

   b. Modification of control algorithm parameters which reside on the local DCP or any remote DCP.

   c. Downloading of a database from any management console in the system.

   d. Uploading of a DCP resident database to any management console in the system.

   e. Updating of the real time clock from any other DCP in the system.

f. Updating of the user definition tables from any other DCP in the system.

g. Capability to process alarms, both local alarms and alarms which are generated from any grouping of other DCPs which are on-line.

h. The DDC control software shall be based upon pre-defined software function blocks. These software function blocks shall be similar to process control hardware components.

i. The system shall provide overlay capabilities for bumpless multi-mode of alternate algorithm operations.

j. All setpoints, constants, and control response shall be completely field adjustable through the entire design ranges.

k. Programming shall permit manual input valves to be entered at any level necessary for operational field testing purposes.

l. An operator security system shall be provided that is identical in function to that of the system management console to prevent unauthorized access.

m. All control loops shall contain proportional, integral, and derivative modes of actions as defined by SAMA Standard PMC 20-1, 1973. The modes of control shall be completely field adjustable.

n. The control panel shall be capable of performing the following control algorithms of combinations thereof: PID control with bumpless transfer; high/low signal selection; comparison of one or more signals against a standard or each other; square foot; polynomial equations; analog signal delay; totalization of two or more signals; track and hold. All algorithms shall have an end-to-end minimum accuracy, regardless of the number of functions use, of 0.25 percent as defined by SAMA Standard PMC 20-1, 1973.

o. All analog input and output points shall be adjustable for high limit, low limit, high alarm, and low alarm.

p. An adjustable input response filter shall be provided for all analog input points to eliminate incoming process, sensor and/or transmission noise.

q. Separately adjustable on and off delay times shall be provided for all binary input and output points.

r. The system, upon restoration of power following a power failure, shall be capable of selectively initializing the database before resuming its normal program. The shall insure that restored critical points are in a safe position before continuing operating without disturbing previous operator parameters.

s. All outputs, through an internal segmented equation or polynomial curve generator, shall linearize all final control devices, e.g., valves, dampers, etc., to provide an output liner with process characteristics. This will make system sensitivity independent of device position. The device characteristics data necessary shall be obtained through published manufacturer's test data or actual field measurement. This data, along with the polynomial coefficients being used, shall be submitted to the Architect for his approval.

t. All binary outputs shall be provided with a hardware power-up initialization to take place before software initialization which shall insure that all of the binary contacts are in the open position upon power application. This will prevent these outputs from initializing in a random state.

u. The DCP shall be expandable to 60 PID loops with a scan rate not greater than 1 second.

v. Each DCP shall be capable of handling up to 200 points.

w. System scan rates shall be variable down to 0.5 seconds for added flexibility.

x. System I/O scanning shall be high speed with update times not to exceed 400 milli-seconds.

8. DCP Failure Mode: Upon detection of a self-diagnosed error, the DCP shall attempt to restart operations if possible. If this is not possible, the DCP shall cease operations. The I/O subsystem, upon recognizing loss of communications with the DCP, shall go to a preselected failure mode.

9. DCP Commands: The DCP shall accept English language commands for defining and selecting points, parameters, and all other functions associated with operation of the DCP.

10. Command Input: DCP commands shall be full English language words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The DCP shall prompt the operator in full English words and acronyms for all required information identifying acceptable command formats. The operator's response shall be an English word, phrase, or acronym including parameters where required.

11. Command Input Errors: The DCP shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors.

a. Conditions for which operator error assist messages shall be generated include, but are not limited to:

1) The command used is incorrect or incomplete.

2) The operator is restricted from using that command.

3) The command addresses a point which is disabled or out of service.

4) The command addresses a point which does not exist.

5) The command would violate constraints.

6) A log of all operator commands and log-ons, successful or otherwise, shall be maintained at the operator's console database.

12. Operator's Commands: Operator's commands shall be provided as part of the DCP software for performing the following tasks:

a. Display any digital or analog point or grouping of points connected to any DCP in the entire networked system.

b. Start-up and shutdown selected systems or devices.

c. Modify point attributes on the local or any remote DCP.

d. Modify point values on the local or any remote DCP.

e. Modify time and event scheduling on the local or any remote DCP.

f. Adjust setpoints on the local or any remote DCP.

g. Select manual or automatic control modes on the local or any remote DCP.

h. Provide alarm indication and processing for the local DCP and any grouping of remote DCPs.

i. Allow time of day modification from any DCP in the networked system.

j. Provide time of day synchronization between the local and all other DCPs in the networked system.

k. Allow modification of user access tables from any DCP in the networked system.

l. Provide user access table consistency among all DCPs in the networked system.

m. Display a menu of operator's commands and a description of each command in response to operator entered help requests.

n. Status of alarms and other information from remote sites.

13. Unique addressing for identification shall be provided for each point in the entire networked system. The unique name for the point should include the DCP the point is located on, the device the point is located on, and a name which is related to the individual sensor or the control device's name. A minimum of six alphanumeric characters shall be allowed for each portion of the point address for a total minimum of eighteen alphanumeric characters to uniquely describe any point in the networked system.

14. System Access Control: Access to data within the system shall be limited by three items; read level, write level, and security zone. There shall be a minimum of 127 read and write levels in the system and a minimum of 20 security zones definable in the system. Each user shall have a read level, write level, and list of security zones they may access when they enter the system. Any data access performed in the system must be verified against these security control items. This security must be maintained across the entire networked system, on both the local and all remote DCPs. The definition of security levels shall be arbitrarily assignable over the entire range of read and write levels. The definition of security areas shall be arbitrary across groupings of points and partitions of the control algorithm.

15. Calculated Point: This value shall be created by calculating it from any combination of digital and analog points, or other data. The result of the calculation will be an analog or digital point having all the properties of real points, including alarms, without the associated hardware. The calculated analog point shall have point identification in the same format as any other analog point. The calculated point shall be used in any program where the real value is not obtainable directly. Constants used in calculations shall be changeable on-line by the operator.

16. Analog Monitoring: The system shall measure and transmit, as specified, all analog values including calculated analog points. An analog change in value is defined as a change exceeding a preset differential value as specified. The record transmitted for each analog value shall include a readily identifiable flag which indicates the abnormal status of the value when it deviates from operator selectable upper and lower analog limits. All analog values shall be expressed in proper engineering unit with sign. An appropriate vocabulary of engineering units shall be provided to provide meaningful translation of binary states to descriptive terms (e.g., ON/OFF, TRUE/FALSE, etc.) and to meaningfully describe analog values (e.g., CFM, FPM, percent, etc.). Scaling Factors shall be provided to scale raw analog input and output counts into meaningful floating point values. The scale factor shall be a polynomial of not less than the 4th degree which can be used to determine range and span of the analog value as well as linearize non-linear end devices.

17. Analog Totalization: Any analog value point shall be totalizable. There shall be no limit on the number of analog values totalized. Each analog value totalized shall have its own totalization time period. At the end of the time period, the total shall be stored. Totalization shall then restart from zero for the next time period. The operator shall be able to set or reset each totalized value individually. The time period shall be modifiable on-line. The program shall keep track of the peak, minimum, and total value measured during the current period and for the previous period.

18. Energy Totalization: The system shall calculate the heat energy in Btu's (ton-hours or KWH), for each energy source consumed the mechanical systems specified, totalize the

calculated Btu's, the instantaneous rate in Btu's per hour, and store totals in millions of Btu's (BTU E06).The Btu's calculated shall be totalized for an adjustable time period. The time period shall be defined uniquely for each Btu totalization. The time periods shall be able to be defined, modified, or deleted on-line.

19. Trending: Any analog and binary input, output, or calculated point may be trended. Each point trended shall have its own sample rate, with a minimum sample rate of not greater than one second to trend real-time data. The maximum sample period must be no less than 24 hours. The number of points in the trend shall be user-definable, and shall at least encompass the range from 64 points to 3,600 points (i.e., 60 minutes of trending sampling once a second) to allow for precise monitoring of selected analog points.

20. Summer-Winter Operation Monitoring: The system shall provide software to change the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system from summer to winter and vice versa. The software shall provide appropriate commands to applications programs to coordinate proper summer or winter operation.

21. DCP Data: Each DCP shall supervise the following alarm and event conditions and manage the communication of alarms and events to other DCPs and management consoles.

    a. The system shall record the time and date of each occurrence of an analog point exceeding its high or low limits or of a binary point entering its abnormal state. The system shall record the time and date that the point returns to normal.

    b. Any communication failure within the system and its subsequent restoration shall be recorded.

    c. Any user changes made to points, parameters, etc. shall be recorded.

    d. Any user changes made to the system clock which resides at each DCP shall be recorded.

    e. Any valid or invalid operator sign-on and all operator sign-offs shall be recorded.

    f. Record alarm conditions as communicated by the DDC system, monitoring system for electric switchgear and monitoring system from remote sites.

22. Report Formatting: All point values and alarm data may be shared across the network by any or all DCPs and management consoles. In addition, all trends in the system may be defined or retrieved by any or all management consoles in the system.

23. DCP Communications Software: Provide all communications software which allows each DCP to transparently access all point, alarm, and control data at all other DCPs in the system. The user at any DCP shall be able to access point and control data at all other DCPs in the system transparently. The communications software at the DCP shall also be capable of communicating with all management consoles in the system. The management consoles shall be capable of making requests to the DCPs including, but not limited to downloading of programs, uploading of programs, downloading of trend definitions, and uploading of trend data. The communications software used shall incorporate error detection, message retry, and packet sequencing in its software or hardware protocols.

24. Function Blocks Programming Modules: all standard operating software necessary to support the control functions described in the specification shall be provided. The DDC System Supplier shall provide as a minimum all software modules specified under this section. The system shall provide stand-alone operation. Interaction between the operators and the control system shall be through the use of a CRT English Language display. Computer programming knowledge shall not be required.

a. PID Control Module: This module shall take a measured variable and shall compare its value to its setpoint. The difference of these values is multiplied by a constant to produce a proportional term. An integral term is calculated and multiplied by the integral gain constant. The difference between the current measured value and the last measured value is multiplied by the derivative gain constant. These terms are used in an equation to produce an output control signal. (Example of application: this module can be used to operate a fan to maintain a constant static pressure.)

b. Dual PID Control Module: this module shall operate as the PID control module, except it shall input two measured variables and a setpoint for each. Two control signal values shall be calculated and the higher of these two signals shall be selected as the output control signal. (Example of application: this module can be used to control a fan from both CFM and static pressure.)

c. Logic Module: the logic function shall be defined by a Truth Table that lists all possible combination of states (on or off) of the four inputs. To specify the gate function, the desired output state shall be selected for each of the 16 input conditions. (Example of application: this module can be used to determine if there are any fans running.)

d. Square Root Extraction Module: this module shall calculate the square root of its analog input and multiply this result by a constant. (Example of application: this module can be used to convert velocity pressure readings into CFM values.)

e. Multiplier Module: this module shall input two analog values and output their products. (Example of application: this module can be used to calculate a percentage of a value.)

f. Signal Comparator Module: this module shall output a binary signal dependent on the difference between two analog values. (Example of application: this module can be used to turn compressors on and off based on outdoor air temperature.)

g. Signal Switching Module: this module shall output either of its two analog inputs based on its binary input. (Example of application: this module can be used to switch between setpoints for different modes of system operation.)

h. Low Selector Module: this module shall output the lowest of its three input values. (Example of application: this module can be used to input the static pressure in a number of ducts and output the lowest one to a controller.)

i. High Selector Module: this module shall output the highest of its three input values. (Example of application: this module can be used to input the static pressure in a number of ducts and output the highest one to a controller.)

j. Binary Connect Module: this module shall connect one binary value to another point. (Example of application: this module can be used to output one binary value to a number of binary points.)

k. Sum Module: this module shall multiply each of its inputs (3 max) by a unique gain constant and output the sum of these terms. (Example of application: this module can be used to calculate the average of three values.)

l. Sum N Module: this module shall output the sum of its inputs. (Example of application: this module can be used to add CFM values to produce a total system CFM value.)

m. Track and Hold Module: this module shall output its input value while its binary input is in the "on" state. The output retains the value once the binary input switches to "off" and will not change until the binary input goes to "on"

again. (Example of application: this module can be used to allow many analog inputs to be transmitted to one data line.)

n. Analog Connected Module: this module shall connect one analog value to another analog point. (Example of application: this module can be used to output one analog value to many analog points.)

o. Timer Module: this module shall switch a binary output to match its binary input after an adjustable on or off time delay. (Example of application: this module can be used to provide time delays in the starting and stopping of chillers.)

p. Ramp Module: this module shall ramp its output up or down from its initial value, depending on its binary input. The ramping function shall occur at adjustable up and down rates. (Example of application: this module can be used to slowly add the capacity of a second fan to a system.)

4.4 OPERATOR'S CONSOLE SOFTWARE

A. The Operator's Console software shall support all specified functions. The standard system software supplied by the computer system manufacturer shall not be modified in any way that would preclude the purchase of a standard maintenance and service contract from the computer manufacturer.

B. Each Operator's Console shall be provided with the following general software:

1. Bootstrap Program: The software shall include a bootstrap program sufficient to initiate operation of the Operator's Console using only procedures specified by the computer manufacturer.

2. Disk Operating System: A publicly available and supported disk operating system equal to the latest version of Microsoft Disk Operating System (MS-DOS) and Windows operating system shall be utilized, featuring:

a. Program control functions including program loading, execution, and termination.

b. Error detection and recovery.

c. Keyboard and display I-O control.

d. Serial and parallel I-O control.

e. File management including creation and deletion of files, searching, sequential and random file access, and maintenance of file directories and subdirectories.

f. Disk/tape management including drive selection, partitioning, space allocation and recovery, write verification, and a copy routine to transfer information between any two devices.

g. Editor software to accomplish input, modification, display, listing, and storage onto the disk files of the source languages.

h. Diagnostic programs to check the status of the Operator's Console on its screen.

a. Maintenance of current date and time.

3. Operator's Console Commands: The operator's console commands shall provide a means for entry of control and monitoring commands, and for retrieval of DDC System information. The operator's commands shall perform tasks including:

a. Request and terminate dial-up communications with any DCP.

b. Perform all tasks provided by the DCP and specified under "DCP Operator's Commands". A single command entered by the operator shall be issued by the

DCP to the device within ten seconds, provided communication with the DCP has been established prior to command issuance.

c. Update any DCP time base from the Operator's Console time base.

d. Request CRT display or printed reports, including a complete status listing for any point or all points in any DCP, all specified trend data, and the intrusion alarm log for any DCP. Point data and reports as specified shall be arranged logically for CRT display.

4. Printer Output: Formats for printed data shall be similar to and consistent with those used in CRT alphanumeric data displays. English language descriptions printed shall be identical to those presented on the operator's console LCD Screen.

C. Operator's Console and DCP Data Exchange Requirements

1. Data exchange shall be provided between the Operator's Console and the DCP's including:

a. Transmission from the Operator's Console to the DCP/RAM resident software, operating parameters and constraints, and operator commands.

b. Transmission from the DCP to the Operator's Console of all data, including parameters of the DE, constraints, and RAM resident software.

2. DCP programs and parameters shall be capable of being transmitted from the Operator's Console to the DCP, including all changes to DCP parameters. DCP parameter changes shall be capable of being performed with the DCP on-line.

4.5 GENERAL HVAC CALCULATION SOFTWARE

A. General: The following paragraphs describe general calculation software which will result in "calculated points". Calculated points shall be provided as called for on the I-O Summary Tables.

B. [Not Used]

C. [Not used]

D. Run Time Calculation: This calculation shall create software points for run time based on actual run time and speed as necessary. The run time shall be measured in increments of 1,000 hours (hrs E03). Scaling factors may be applied for systems with variable speed drives or two-speed drives. Refer to maintenance alarm in Paragraph 4.6, Subparagraph Q for further requirements.

E. Flow Calculation: This calculation shall create software points for flow (CFM, #/hr., GPM, etc.) based on differential pressure, pressure, and temperature as necessary. This calculation shall include a method of inputting a characteristic equation for the specific flow measuring device such as a pitot tube or orifice meter.

F. Energy Flow Calculation: This calculation shall create software points for energy flow (MBTUH or tons) based on fluid or gas flow (CFM, #/hr., GPM) and differential temperature (_F). It shall also create software points for energy flow (KW) based on a pulsed input.

G. Utility Consumption Calculation: This calculation shall create software points for total energy consumed (Btu E09, ton-hours E06, KWH E03) through integration of the energy flow data. It shall also totalize other utility usages (natural gas - CuFt E06, Steam - pounds E06, water - gallons E09, medical gases - CuFt E06). In addition, the calculation shall calculate heating and cooling consumption weather data, i.e., heating-degree days based on outdoor dry bulb temperature and 65°F, cooling-degree days based on outdoor wet bulb temperature and 62°F w.b. Utility usages shall be stored on a monthly and an annualized basis. Available data shall include month-to-date, year-to-date, previous 24 months, previous 10 years. Each monthly utility consumption data collection system shall be field programmable to start and end on the same dates as the utility company starts and ends its billing period. The calculation shall also have an input for up to four

unit costs and usage levels. These unit costs shall be manually input and shall produce a monthly billing.

H. Utility Demand Calculation: This calculation shall create software points for all maximum, minimum, and average utility demands. Based on flow data, energy consumption data, or utility consumption data (CFM, KBTUH, tons, pounds per hour, CFH, GPM, KW, etc.). The data shall be collected on a monthly basis which coincides with the utilities' normal billing period. The peak and minimum utilities shall be recorded based on the highest average usage over a 15-minute period. The average demand shall be calculated using the total monthly consumption divided by the time in the monthly billing period. Available data shall include month-to-date, year-to-date, previous 24 months. Each data point shall be accompanied by a time of occurrence (end time), date, outdoor dry bulb temperature, and outdoor wet bulb temperature (as applicable). The calculation shall also have an input for up to four unit costs and usage levels. These unit costs shall be manually input and shall produce a monthly billing.

I. Efficiency Calculation: This calculation shall create software points for efficiency based on an equipment device's total output and its major controlling input. For example, for electric chillers the calculation would measure KW/ton; for absorption chillers the calculation would measure pounds of steam/ton-hour, for boilers the calculation would measure gross Btu's input/net Btu's output.

4.6 DCP APPLICATIONS SOFTWARE

A. General: Provide the following applications programs, associated constraints, and interlocks as specified and as required by the I-O Summary Tables, resident and executing in the DCP. The system shall perform all functions specified in the I-O summary tables by use of the appropriate application programs. All applications programs shall be coordinated, one with the other, to insure that no conflicts or contentions remain unresolved. Refer to control drains H8.## for sequences.

B. Program Inputs: Select the appropriate program inputs listed for each application program to calculate the required program outputs. Where the specific program inputs are not available, such as no status indication called for on the I-O Summary Table, provide a "default" value to replace the missing input, thus allowing the application program to be tested. All analog inputs to application programs shall have an operator adjustable deadband to preclude short cycling or hunting.

C. Scheduled Start-Stop Program: This program shall start and stop equipment based on the time of the day and day of the week, including holidays. To eliminate power surges, an operator adjustable time delay shall be provided between consecutive start commands. The program must execute entirely on the DCPs.

1. Program Inputs

   a. Day of week/holiday.

   b. Time of day.

   c. Summer and winter high-low limits.

   d. Summer and winter start-stop schedules.

   e. Summer or winter operation.

   f. Equipment status.

   g. Equipment constraints.

2. Program Outputs:

   a. Start signal (momentary or maintained as specified).

   b. Stop signal (momentary or maintained as specified).

D. Optimum Start-Stop Program:

1. Refer to control drawings.

E. Duty Cycling Program:

1. Refer to control drawings.

F. Day-Night Setback Program.

1. Refer to control drawings.Inputs

G. Dry Bulb Economizer Program:

1. Refer to control drawings.

H. Enthalpy Economizer Program: DDC system shall include a software program to perform enthalpy optimization of air handling units. The program shall calculate the enthalpies of both the outside air and the return air, and shall control the mixture of the outside air and return air to minimize energy consumption. The program shall compute enthalpy from the dry bulb temperature and relative humidity of the outside and return air and shall use all necessary tables and equations to calculate the proper enthalpies. The program shall control the mixture of outside air to return air, based on the desired supply air temperature and the relative outside and return air conditions. Select whether each air handler is to be controlled by the enthalpy program or the mixed air local loop controller. Request a display showing the outside and return air temperatures, humidities, enthalpies and control mode for each air handler under the enthalpy program control. Adjust the minimum interval at which the enthalpy program computes enthalpies and optimizes the operation of the air handlers. The program must execute entirely on the DCPs.

1. Program Inputs

a. Changeover enthalpy value

b. OA dry bulb temperature

c. Return air dry bulb temperature

d. OA relative humidity

e. Return air relative humidity

f. OA intake damper position

g. Return air damper position

h. Relief air damper position

i. Equipment constraints

2. Program Output: Automatic (modulating) or minimum OA damper control signal.

I. Ventilation-Recirculation Program:

1. Refer to control drawings.

J. Reheat Coil Reset Program: The software shall select the zone with the least amount of heat required. The program shall reset the cold deck discharge temperature upward until it satisfies the zone with the lowest demand, or until the zone humidity control requirements cannot be met. The program must execute entirely on the DCPs.

1. Program Inputs

a. Zone relative humidity high limit.

b. Zone temperature (where shown).

c. Zone relative humidity (where shown).

d. Supply air temperature.

e. Reheat coil valve positions or proportional signals from primary elements.

f. Minimum space temperature during occupied periods.

g. Maximum space temperature during occupied periods.

h. Equipment constraints.

2. Program Outputs: Cold deck temperature setpoint.

K. Chilled Water Reset Program: DDC system shall include a software program to perform chilled water reset. The program shall optimize the use of chilled water in one of two ways. This chilled water supply reset shall be based on either maintaining a constant return temperature or supplying sufficient cooling to satisfy zone requirements. The system operator shall be able to define, modify, and delete the loops to be enabled/disabled, high and low reset limits, incremental adjustment magnitude, and sampled time interval. A log shall be provided detailing each parameter associated with a chilled water test loop. The program must execute entirely on the DCPs.

1. Program Inputs

a. Reset schedule

b. Chilled water temperature

c. Maximum chilled water temperature

d. Minimum chilled water temperature

e. Zone temperatures

f. Maximum zone temperature during occupied periods.

g. Minimum zone temperature during occupied periods.

h. Equipment constraints

2. Program Outputs: Chilled water temperature setpoint

L. Hot Water OA Reset Program: The software shall reset the hot water temperature supplied by the boiler or converter in accordance with the OA temperature. The hot water supply temperature shall be reset downward or upward from a specified temperature proportionally as a function of OA temperature. The program must execute entirely on the DCPs.

1. Program Inputs

a. Reset schedule.

b. OA dry bulb temperature.

c. Maximum hot water (HW) supply temperature.

d. Equipment constraints.

2. Program Outputs: HW temperature setpoint.

M. Peak Demand Limiting Program: DDC system shall include a software program to perform Peak Demand Limiting (PDL) on a system-wide basis. The PDL program shall monitor the rate of electrical power consumption and forecast the total demand. The PDL program shall automatically shed loads throughout the system to reduce demand. The PDL program shall be able to accommodate a minimum of 64 demand meters. It shall be possible to define a minimum of 64 separate service areas, each of which may have different power company demand interval pulse times. It shall be possible for the operator to set load schedules and demand limits in each service area separately. Each service area shall perform demand prediction and subsequent load shedding and restoring independently. Loads shall be divided into user-defined shed schedules that include a minimum of four priority levels. All loads in the lowest priority level must be shed in a rotational manner before any load in the next priority level is shed. Each load shall be defined

as to its rated power consumption in KW or HP and its maximum off time, minimum off time and minimum on time. These time parameters shall ensure load is not shed or restored too frequently to cause damage to a load. The PDL program shall be designed to accept sliding window metering systems as well as time of day metering. The demand shall be predicted each minute, and loads shed as needed. If all sheddable loads are shed by the PDL program and it is forecast that the user-defined demand limit will be exceeded, an alarm message shall be printed. Due to the nature of this program, and the amount of data sharing involved, it is acceptable to allow this program to run either on the DCPs, on a management console, or a combination of the two.

1. Program Inputs
    a. Load shed schedules
    b. Meter KW demand
    c. Day of week/holiday
    d. Time of day
    e. Maximum monthly KW demand
2. Program Outputs
    a. Stop signals to individual loads in accordance with prioritized load shed schedule.
    b. Start signals to individual loads in accordance with prioritized load shed schedule.
3. The automation system operator shall be able to request the following reports:
    a. In the event of CPU or communication failure, each remote unit shall be able to continue controlling demand in its own area.
    b. Meter area load table detailing assigned load parameters, such as load name KW rating, minimum on time, minimum off time, etc.
    c. Meter report for a meter area detailing name of meter, scaling factor, default failure rating.
4. The system shall provide the following automatic reports:
    a. 24-Hour Energy Summary. This summary will list the demand versus time for each shed setpoint in the last 24 hours.
    b. Monthly Summary Report. This summary lists the peak demand occurrences for each meter area for a one-month period.
    c. Printed Plot of Actual Demand Versus Time. For the previous 24 hours the system shall print a plot for each meter area detailing time, KWH used and setpoint.
    d. Any other reports as specified.
5. Emergency Electrical Power Consumption Program Inputs
    a. Load shed schedules.
    b. Metered KW demand at the generators.
    c. Metered KW demand from various users.
    d. Available KW capacity.
    e. Position of emergency transfer switches.
6. Emergency Electrical Power Consumption Program Outputs

a. Start-stop signals to essential HVAC systems.

b. Low speed operation start-stop signals to essential HVAC systems with 2-speed starter.

c. Limited speed operation start-stop and maximum speed signals to essential HVAC Systems with VF drives.

d. Indication to the operator that the "load" is in "PDL" override upon request.

7. Chilled Water Demand Limit Program Inputs

a. Load shed schedules.

b. Individual chiller water bridge demand - tons.

c. Individual chiller water bridge demand - GPM.

d. Individual chiller water bridge demand - CWS temperature.

e. Individual chiller water bridge demand - CWR temperature.

f. Maximum tons available - plant.

g. Maximum GPM available - plant.

h. Time of day.

i. Maximum monthly tons demand (historical).

j. Maximum monthly tons demand to date.

k. Maximum CWS temperature to individual chilled water bridge from reset program.

l. Temperatures and humidities for critical users.

8. Chilled Water Demand Limit Program Outputs.

a. Increase supply air discharge temperatures at individualized air handling units in accordance with prioritized load shed schedules.

b. Increase chilled water supply discharge temperatures at individual chilled water bridges or at the chillers themselves in accordance with a prioritized load shed schedule.

c. Start and stop pumps serving chilled water bridges if use is not required.

d. Indicate to the operator that the "load" is in PDL override upon request.

9. The DDC System operator shall be able to request the following reports:

a. In the event of an Operator's Console or DCP communication failure, each DCP shall be able to continue controlling demand in its own area.

b. Meter area load table detailing assigned load parameters, such as load name KW rating, minimum "on" time, minimum "off" time, etc.

c. Meter report for a meter area detailing name of meter, scaling factor, default failure rating.

10. The system shall provide the following automatic reports:

a. 24-Hour Energy Summary: This summary will list the demand versus time for each shed setpoint in the last 24 hours.

b. Monthly Summary Report: This summary lists the peak demand occurrences for each meter area for a one-month period.

c. Printed Plot of Actual Demand Versus Time: For the previous 24 hours, the system shall print a plot for each meter area detailing time, KWH used and setpoint.

11. Each fan or pump connected to emergency power shall be programmed in software to be associated with a particular transfer switch such that when the switch is transferred between two power sources, the loads associated with the switch can be turned off prior to transfer. Refer to "Electrical Transfer Switches" for further requirements.

N. Control Sequences: All control sequences shall be modifiable by the operator. It shall be possible to perform parameter value changes while the system is on-line and running. To provide for minimum impact in the system caused by changing a sequence while it is running, substantial changes to the control sequences may only be made at a the main operator's console. These changes may then be downloaded to any DCP for execution. Each DCP shall be supplied with a minimum of 15 percent free CPU capacity. The event that meeting this criteria would cause the splitting of critical control sequences, the next nearest DCP may contain the additional spare capacity for its neighbor.

O. [not used]

P. [not used]

Q. Alarms

1. Alarms will be programmed in three levels minimum. These will differentiate between critical, abnormal, and maintenance.

a. Critical alarms would include equipment failures, freezestats, smoke, etc. and would demand immediate attention by the highest level of the maintenance staff. These alarms would be printed immediately and would sound audible alarms as provided.

b. For critical alarms, the following capability shall be provided. If a critical alarm is not acknowledged in a predetermined Supplier and the DDC System Installer. Refer to H8.03 Exhibit halls sequence varies.

c. Exhaust fans in Engineered Fire Control Systems will normally not be affected by evidence of fire. They will continue to run or (operator adjustable) time, then the Operator's Console shall automatically call a user defined phone number for PUH paging and send an alarm on the operator's pager. This is necessary to ensure that the operator does not miss a critical alarm when he is away for short periods of time. Additionally, the alarm information may be displayed at the Security Station, other Operator Consoles, or communicated to the supervisor over the phone.

d. Abnormal alarm would include high and low temperature readings, acknowledged critical alarms, standby pump in operation, equipment being out of service for maintenance. These alarms would demand immediate attention by the next normal day-shift maintenance staff. These alarms would be displayed immediately at their assigned alarm point designation.

e. Maintenance alarms would include any other alarm such as dirty filters, run-time alarms for preprogrammed maintenance, etc. Run time alarms shall be set up on each device shown in the I/O summary tables. These alarms shall be disk filed in ASCII format with respect to date, time, system, point name and chronological event number. In addition, the date and time of the subsequent service work shall also be disk filed. These alarms would be printed only when requested.

f. All alarms shall be user-programmable to any level and to any alarm point destination (Operator Consoles). Alarm point destinations may be programmed

to change automatically by the time of day, day of week, etc. All alarm point attributes high and low levels shall also be user-programmable.

g. In case of alarms not being acknowledged, the DDC System shall call up to three user-designed alpha pagers via STMP.and relay an appropriate alarm message This message shall be repeated a user-defined number of times.

4.7 GRAPHICS SOFTWARE

~~A.~~ Operational Color Graphics

1. The operator shall be able to perform the following operations by using a mouse-driven user interface to "point and click."

   a. Examine process variables and operating conditions.

   b. Adjust setpoints and other process parameters.

   c. Collect, report and plot trended data.

   d. Define and augment control strategies.

   e. Upload and download control data and algorithms.

2. Building/Creating Color Graphics

   a. The operator shall be able to create and modify graphic schematics, building floor plans and other facilities oriented displays. Color Graphics displays shall be created by using the operator's keyboard or mouse or any combination thereof. The minimum capabilities shall include:

      1) Create and save symbols.

      2) Create and save pages.

      3) Group and ungroup symbols.

      4) Modify an existing symbol.

      5) Modify an existing graphic page.

      6) Rotate and mirror a symbol.

      7) Place a symbol on a page.

      8) Place analog dynamic data in decimal format on a page.

      9) Place binary dynamic data using state descriptors on a page.

      10) Create motion through the use off gif, jpeg or bmp files

      11) Place test mode indication on a page.

      12) Place manual mode indication on a page.

      13) Place links using a fixed symbol or flyover on a page.

         a) Links to other graphics.

         b) Links to web sites.

         c) Links to notes.

         d) Links to time schedules.

      14) Assign a background color.

      15) Assign a foreground color.

      16) Place alarm indicators on a page.

17) Change a symbol color as a function of an analog variable.

18) Change a symbol color as a function of a binary state.

19) Change symbols as a function of a binary state.

20) All symbols used by the contractor in the creation of graphic pages shall be saved to a library file for use by the owner.

b. The graphics package shall contain a standard symbol reference where an operator can select already created objects such as air handlers, fans, pumps, etc., and place them in desired locations while creating graphic diagrams.

c. It shall be possible to place live updating field point data and calculated data anywhere as desired in the diagram.

d. Color graphics shall be user friendly and shall include a menu which includes standard symbols for constructing "new" color graphics or for modifying existing color graphics. All symbols shall include required data fields which can be "snapped" to for control by the mouse. These symbols shall be readily able to be enlarged or reduced to fit the final graphics. All symbols shall be user programmable for color based on its operation status. Refer to the control drawings for all points/components/systems to be on the graphics.

3. The graphics package shall also include a menu for creating graphics from "scratch." This portion of the graphics package would be created similar to an AutoCadd drawing and the final drawing would include all attributes for mouse control as required previously in this paragraph.

4. The color graphics shall use AutoCadd type floor plans for the facility.

5. Graphic points shall be bound on line without having to assign any logical point types.

4.8 WEB SERVER SOFTWARE

A. This software shall enable operators to access the system from remote computers using only browser software. The software shall allow for a minimum of five (5) concurrent users. Once connected to the system the operators shall be able to execute the following tasks:

1. View dynamic data in a real time environment in both point list format and in a graphical page format.

2. View and acknowledge alarms.

3. Adjust time schedule parameters.

4. View historical trend data in table and graph formats.

5. View dynamic real time trends in graph format.

6. Run established reports.

7. Manually adjust application parameters.

8. Manually override physical inputs (sensor values) and force a specific value as an input to control logic.

9. Manually override physical outputs (end devices) and force a specific value regardless of the command from the control logic.

B. The Web Delivery System shall have the capability to expand to 25 concurrent web-client users looking at the same hardware environment subject to the purchase of additional software licenses.

END OF DDC PART 4

PART 5 - GENERAL SEQUENCES OF CONTROL

5.1 SCOPE

A. This Section covers "General Sequences of Control" which are to be followed throughout the length of this contract.

B. The control strategies on the control drawings (F-H800 through F-H 808) shall be used in conjunction with the matrices for controller drawings herein for engineering the control systems and preparing the required control drawings.

C. The control matrices and the sequence have been made to compliment each other. In addition, due to the nature of some controls, more or less hardware points may be necessary to accomplish the intent. The DDC System Supplier shall include all such hardware necessary to accomplish this task at no additional cost to the "unit costs". The DDC System Suppliers shall also treat the sequences and the matrices such that if a device is called for in one and not the other, it will be treated as if called for in both.

D. Control of all HVAC equipment shall be through the DDC system unless each individual sequence specifies otherwise. If a particular sequence specifies pneumatic controls for certain HVAC equipment, pneumatic controls shall be provided for the HVAC equipment identified under that sequence only.

E. In preparing the unit cost for the work, refer to Part 1 of this specification. Refer to paragraph 1.16 for other unit pricing requirements. The unit prices for these sequences are to include all valves, dampers, sensors, DCPs, DTCs, UCPs and other hardware required.

F. When executing this work on this project, all Division 15 requirements for the project shall apply. In case of a discrepancy between the requirements of the project and this document, the most stringent requirement shall apply. If this happens, the matter shall at once be brought to the attention of the Architect/Engineer, the C.M., and the Owner.

G. If significant changes are made to a control sequence for a future project, the control sequence nearest to the one desired shall be utilized. If significant changes in hardware are required, the same could be done for various control components from unit prices.

H. The unit prices for the control sequences shall include the labor cost for the DDC System Supplier to interface with future project engineering and to provide detailed installation drawings that can be included in the future bid packages for obtaining installation prices.

I. The control sequences given in this section will be used to price the additional work.

J. The following Generic DDC Control Sequences are found at the end of this section

END OF PART 5

PART 6 - LABORATORY AIRFLOW CONTROL SYSTEM

6.1 DESCRIPTION

A. A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms and other spaces within the facility. The exhaust volume of each laboratory fume hood shall be precisely controlled by an Adaptive Face Velocity controller to maintain a constant average face velocity into the fume hood at either a standard/in-use or standby level based on actual hood usage. The laboratory control unit shall vary the amount of air into the room and hot water to the reheat coil in order to maintain temperature control, minimum ventilation, airflow balance, and laboratory pressurization in relation to adjacent spaces (positive or negative). All spaces within the lab facility shall be precisely controlled to maintain the required pressure characteristics and to maintain minimum ventilation and airflow balance in relation to adjacent spaces. Approval to bid does not relieve the Laboratory Controls Contractor from complying with the intent and requirements of these specifications.

6.2 ACCEPTABLE MANUFACTURERS

A. The plans and specifications for the laboratory airflow control system and the sizing of the air delivery systems, heating and cooling capacities, and diversity have been based on systems and equipment as manufactured by Phoenix Controls. The specified systems and equipment shall be a digital, network-able system which will interface with the specified Building Automation DDC system over BACNetTM industry standard communication protocol level 5. Manufacturers must meet factory calibration. Manufacturer is to pay for field calibration if required.

B. Experience – The Laboratory Controls Contractor shall provide a list of at least three laboratory projects of like size and scope installed within a 100 mile radius of the project site

6.3 CONCORDANCE

A. The manufacturer shall provide a separate concordance schedule, which shall include the section, paragraph, and subparagraph of these specifications and direct statement to indicate compliance or non-compliance with the requirements. For all areas of non-compliance the manufacturer shall describe what specific and alternative approach has been taken and document the impact this will have on the sizing of the air delivery systems, the required cooling and heating capacities, energy costs, and diversity of the building.

6.4 WARRANTY

A. Warranty shall commence upon the date of system acceptance and extend for a period of thirty-six (36) months for parts and five (5) years for software calibration, labor for all sensors, air flow devices and equipment to keep and maintain proper balance and containment during which time any defects in materials or system performance shall be repaired by the manufacturer at no cost to the owner. In addition any releases in software shall be installed in the system during the warranty period at no additional cost to the Owner.

6.5 PREVENTIVE MAINTENANCE

A. The laboratory airflow control system supplier shall provide a unit price for an extended maintenance program during and after the warranty period, the unit price will be based on a one (1) year duration and shall remain valid for up to a five (5) year duration. This preventative maintenance shall cover all airflow sensors (e.g., pilot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.) and flow transducers provided under this section. Airflow sensors shall be removed, inspected, and cleaned annually during this extended maintenance period to prevent inaccuracies due to long term buildup of corrosion, lab tissues, wet or sticky particles, or other materials that foul the sensor. If impracticable to remove the airflow sensors, the laboratory airflow system supplier shall include in his proposal the cost of supplying and installing duct access doors, one for each sensor. The transducer shall be checked and recalibrated annually to insure long-term accuracy. Note that auto-zero recalibration of transducers is not acceptable as a substitute for annual recalibration.

6.6 LABORATORY AIRFLOW CONTROL SYSTEM

A. The laboratory airflow control system shall be a fully stand-alone digital system for each individual laboratory. The system shall not use or rely on information from controllers in other laboratory areas to control the functions within its laboratory. Some non-laboratory spaces shall be controlled the same as or similar to laboratory spaces in order to assure overall air flow balance.

B. The laboratory airflow control system shall employ individual Face Velocity controllers which directly measure the area of each fume hood sash opening and proportionally control the hood's exhaust airflow in a variable volume mode to maintain a constant face velocity over a minimum range of 20 to 100% at full sash opening. Safety and energy savings shall be insured through a corresponding minimum change in hood exhaust flow of 5 to 1. The value of the hood's face velocity shall also be automatically switched to in-use level based on operator usage of the hood, anytime the laboratory is in the unoccupied mode. Response time shall be less than one second with no more than a 5% overshoot or undershoot. The system shall achieve 90% of its commanded

volume within one second of the sash reaching 90% of its final value with a full height sash movement of one second.

C. The laboratory airflow control system shall respond and maintain specific airflow (+ 5% of signal) and stability (< 5% over/undershoot) within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifolded system.

D. The laboratory airflow control system shall also maintain intersystem stability within one second of a change in pressure and/or flow to eliminate hunting, system oscillations, and crosstalk between airflow controllers.

E. The laboratory airflow control system shall use volumetric offset control to maintain room pressurization. The system shall respond to and maintain room pressurization (negative or positive) within one second of a change in room/system conditions.

F. The laboratory airflow control system shall employ highly accurate airflow controllers (+ 5% of signal) with a minimum 15 to 1 turndown to insure accurate pressurization at low airflows and guarantee the maximum system diversity and energy efficiency without exceeding 2,000 fpm velocity through any airflow device and not lose specified accuracy through the entire range of the flow device.

G. The laboratory airflow control system shall control the supply air volume and reheat coil valve in order to maintain the temperature setpoint of the space. In laboratories with fume hoods this temperature control scheme shall include measurement of the supply discharge air temperature and calculation of the thermal load in the space. This will allow the system to respond, in an anticipatory manner, to large air volume changes caused by the opening or closing of the fume hoods without creating large temperature swings.

H. The laboratory airflow control system shall maintain the minimum required ventilation for each space regardless of the thermal or make-up air requirements at any particular time. The minimum ventilation rate shall be switched between the occupied rate and the unoccupied rate based on either time of day scheduling or room occupancy based on fume hood sash movement.

I. The laboratory airflow control system shall include a jumbo mushroom pushbutton with maintained contacts for room emergency override at the exit of each laboratory space. The activation of this emergency override will cause all flow control devices to move to a user definable controlled state of flow and remain in that condition until the button is released. Override control schemes which place the flow control devices into an uncontrolled, wide open, state during emergency or any loss of power, or compressed air condition will not be acceptable.

J. The laboratory airflow control system shall incorporate an enhanced function space temperature sensor to provide the following additional features:

1. Adjust the space temperature setpoint up or down within user definable limits.
2. Local readout of space temperature and setpoint.
3. Initiate a timed local override of the scheduled unoccupied mode.
4. A local point of system network connection for a lap-top computer.

6.7 VENTURI AIR TERMINAL UNIT

A. The airflow controller shall be of the venturi valve control type. The valve shall be manufactured and assembled in the United States, including all materials, no exceptions.

B. The valve shall be pressure independent over a 0.30" to 3.0" W.C. drop across the valve. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifolded system. Each venturi air valve shall be provided with a pressure sensing device, which will alarm the system if adequate pressure differential is not sensed.

C. Airflow accuracy shall be +5% of reading (not full scale) over an airflow turndown range of no less than 15 to 1 and not exceeding 2000 fpm. No minimum entrance or exit duct diameters shall be required to ensure speed of response, accuracy, or pressure independence. Systems requiring minimum duct diameters shall be required to furnish and install whatever additional ductwork is needed to meet the manufacturers published requirements. The cost of this additional ductwork, fittings, and engineering shall be included in the lab airflow control systems vendor's bid.

D. The airflow control device shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.

E. The airflow control device shall store its control algorithms in non-volatile, re-writable memory. The device shall be able to stand-alone or be able to network with other room level digital airflow control devices over a 78k baud network.

F. The airflow control device shall use industry standard 24 vac power.

G. The airflow control device shall have a local EIA-232 port for connection to a notebook PC commissioning tool. All software required shall be delivered to the Owner for installation on the Owner’s laptop computer. Assist and instruct the Owner as required for installation and operation on the software.

H. The airflow control device shall accommodate a universal point expansion module to address fume hood control, temperature control, and non-network sensors.

I. The airflow control device shall meet FCC Part 15 Subpart J Class A, and be UL916 listed.

J. The valve shall be constructed of one of the following two types:

1. Supply and general exhaust air assembly shall be constructed of 16 gauge aluminum. All bearing surfaces shall be made of a composite Teflon or Teflon infused (versus coated) aluminum. The assembly's shaft, pivot arm, shaft support brackets, and internal mounting hardware shall be made of 316 series stainless steel. Lesser grade stainless steel materials are unacceptable.

2. Fume hood, canopy, snorkel, and biosafety cabinet exhaust assemblies shall have two baked-on coats of a corrosion resistant phenolic coating (Heresite P403 or Phenolflex 957). The assembly's shaft shall be 316L stainless steel with two additional baked-on coats of a corrosion resistant phenolic coating. The pivot arm, shaft support brackets, and internal mounting hardware shall be made of 316L stainless steel. All bearing surfaces shall be made of a composite Teflon or Teflon infused (versus coated) aluminum. Non-coated shafts and lesser grade stainless steel materials are unacceptable. Bladder valves is this application shall be 316L stainless steel enclosed bladder.

K. A high speed electric actuator shall be factory mounted to the valve. Loss of power air shall cause exhaust valves to fail open to the maximum scheduled design flow for the project, and supply valves to fail to the minimum scheduled design flow. Fail in last position electric actuators/controllers that fail to uncontrolled flows are not acceptable.

L. Certification:

1. Each airflow control valve shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of at least +1% of signal over the entire range of measurement. Electronic valves shall be further calibrated and their accuracy verified to +5% of signal at forty-eight different airflows across the full range of the valve per valve. All valve calibration shall be adjusted for the elevation of the specific location (above sea level) and verified with certified testing documentation to be submitted.

2. All airflow valves shall be individually marked with valve specific, factory calibration data. As a minimum, it should include; valve tag number, serial number, model number, eight point valve characterization information (electronic valves), and quality control

inspection numbers. All information shall be stored on computer diskette in ASCII format for future retrieval or for hard copy printout to be included with as-built documentation.

3. All venturi airflow valves and bladder valves will be configured as part of the Digital Networked System with the exception of the constant volume valves. Each VAV valve shall be either a Digital Node on the network or a virtual node connected to a digital node. Some valves may be configured as a booster valve electronically connected to a digital valve but controlled by the same signal such that both valves act as one.

6.8 EXHAUST AND SUPPLY VALVE AIRFLOW CONTROLLER

A. The controller shall use DDC based, closed loop control to regulate air volume linearly proportional to a 0 to 10 volt or 4-20ma electronic control signal. The valve shall generate a DDC based 0 to 10 or 4-20ma volt feedback signal linearly proportional to its airflow for internal volume control, or airflow tracking control.

B. Each digital valve controller shall control and communicate digitally via a high-speed (78 Kbaud) room level digital network using the RS-485 protocol) with up to fifty (50) digital fume hood, canopy, snorkel, biosafety cabinet, general exhaust, makeup, and laboratory office airflow control devices within a particular pressurization zone.

C. Any digital valve airflow controller shall have the ability to accept a point expansion module (PEM) for the purpose of providing for analog signal input and output for external devices, i.e. reheat coil valve and space temperature.

D. Point Expansion Module

E. The Expansion Module shall provide the following input / output capability:

1. Five universal inputs, jumper configurable to accept 0-10 vdc, 4-20 ma, 10K ohm thermistors, and software configurable for contact closures.

2. Two analog outputs, jumper configurable to provide 0-10 vdc or 4-20ma.

3. One digital output (Form C relay, contacts rated for 1 amp @ 24 Vac or 30 Vdc).

6.9 VENTURI AIR TERMINAL - CONSTANT VOLUME

A. The venturi air terminal shall maintain a constant, manually adjustable, volume setpoint. It shall be factory calibrated and set for desired airflow rate. It shall also be capable of field adjustment for future changes of desired airflow rate. Constant volume valves requiring feedback shall generate a 0 to 10 volt feedback signal linearly proportional to its airflow for DDC monitoring or airflow tracking control.

6.10 LABORATORY CONTROL UNIT

A. A laboratory control unit shall be supplied to control the airflow balance of the laboratory room. As a minimum, provide one complete, stand-alone laboratory control unit per laboratory or per (room) space requiring an air volume supply to exhaust air offset, or if space is served by an air terminal that is not set as a constant volume unit.

B. The control unit shall be of DDC design with analog signal inputs and outputs. The inputs shall accept signals proportional to fume hood, canopy, snorkel, biosafety cabinet exhaust, and supply flows. The controller shall also accept temperature signals corresponding to the space humidity; space temperature and if required the supply discharge temperature or humidity. Additionally the controller will accept a space pressure reading, remote emergency override contacts, and space occupancy sensor input. The output signals shall control supply valves, general exhaust/return air valves, and/or variable frequency drives with signals linearly proportional to the desired supply or exhaust volumes. The outputs shall also control the supply air reheat coil, any auxiliary heating device such as perimeter fin-tube, and or humidifier control.

C. The control unit shall maintain a constant, adjustable offset between the sum of the room's total exhaust and the make-up/supply air volumes. This offset shall be independent of the exhaust

volume magnitude and represent the volume of air that will enter (or exit) the room from the corridor or other room.

D. A Lab Control Unit (LCU) shall control the supply and/or general exhaust airflow control devices to maintain proper room pressurization polarity (positive or negative). Each individual laboratory with fume hoods shall have a dedicated LCU. Laboratories without fume hoods which contain simple airflow tracking pairs will be connected to a supervisory LCU for area level network interface, up to fifty (50) tracking pairs may be connected to a single LCU.

E. The LCU shall a be microprocessor-based digital controller. It shall control and communicate digitally (a high-speed room level digital network using the RS-485 protocol) with up to thirty one digital fume hood, canopy, snorkel, biosafety cabinet, general exhaust, makeup, and laboratory office airflow control devices within a particular pressurization zone.

F. All points shall be available through the interface to the building management system (BAS) for trending, archiving, graphics, alarm notification, and status reports. Laboratory airflow control system performance (speed, stability, and accuracy) shall be unaffected by the quantity of points being monitored, processed, or controlled and must be proven showing a total "through put" document certifying speed and lack of communication bottlenecks.

G. Refer to the BAS specification for the required input/output summary for the necessary points to be monitored and/or controlled.

H. The LCU shall have the capability for full stand alone operation; it shall also be capable of communicating digitally, using the RS-485 communication protocol, with up to 100 LCUs or Bus Interface Cards over the high-speed building wide digital laboratory control system digital network furnished by the laboratory control system supplier.

I. The LCU shall provide an RS-232 port for connecting a notebook computer, desktop computer, modem, or alarm printer. This RS-232 port shall provide access to all points on the Network.

J. The LCU shall accommodate a universal point expansion module to address temperature control and non-network sensors.

K. LCUs mounted below 10' AFF in occupiable areas shall be flush-mount panel mounted in a NEMA enclosure and shall operate on 24 vac power.

L. The LCU shall meet FCC Part 15 Subpart L Class A, and be UL916 listed.

M. An integral or wall-mounted power supply shall be included to power the complete individual space laboratory airflow control system from one dedicated 120 VAC line connection.

N. Point Expansion Module

1. A Point Expansion Module shall be available to be added to the digital electronics of the airflow control device or the LCU, for the purpose of providing for analog signal input and output.

2. The point Expansion module shall provide the following input / output capability:

3. Five universal inputs, module per configurable to accept 0-10 vdc, 4-20 ma, 10K ohm thermistors, and software configurable for contact closures.

4. Two analog outputs, jumper configurable to provide 0-10 vdc or 4-20ma.

5. One digital output (Form C relay, contacts rated for 1 amp @ 24 Vac or 30 Vdc).

O. Interface to Building Automation Systems (BAS)

P. The laboratory airflow control system network shall be required to digitally interface with the DDC Building Automation System. The required software interface drivers shall be developed and housed in an BacNet Gateway level 5, a dedicated interface device furnished by the laboratory airflow control system supplier.

6.11 INSTALLATION

A. The laboratory controls contractor (LCC) shall install the sash sensors, interface boxes, and the monitor on the fume hood. Vertical sash sensors and their stainless steel cables shall be hidden from view. Sash interface boxes with interface cards shall be mounted within an accessible location.

B. The electrical portion of the DDC system shall be installed according to the following provisions:

1. Designated circuit breakers shall be provided in various electrical distribution panel boards for powering the DDC system.

2. The DDC System Installer shall provide all power wiring required for the various apparatus control panels and DDC panels (UCPs) and sensors from these circuit breakers.

3. The DDC System Installer shall provide supplemental branch circuitry and short circuit protection including panel boards as required for proper power distribution, protection and operation of his system and equipment.

4. All wiring, conduits, additionally panel boards, etc., required to provide power for the individual DDC equipment items shall comply with the National Electrical Code (NEC), the requirements of the Montgomery County, MD, and other applicable codes.

5. All other electrical wiring shall comply with the National Electric Code, the requirements of the Montgomery County, MD, and other applicable requirements and shall be installed by licensed journeyman electricians.

6. All peer-to-peer connections to the DDC system and the peer-to-peer network wiring and conduit shall be installed in locations identified by the DDC System Supplier in conjunction with the Architect/Engineer.

7. All DCPs, DTCs, and UCs, for the steam meters, shall be powered by normal/emergency power circuits.

8. All wiring shall be properly color-coded or identified (using terminal numbers) or both at the termination point in the DCP and DTC panels so that wiring between the panel and the sensing/control device can be easily identified.

C. All control wire and power wiring shall be provided by the DDC System Supplier. All wiring, including copper and fiber network wire in exposed areas, inaccessible ceilings and mechanical rooms shall be installed in watertight EMT conduit. Wire in all other areas may use plenum rated cable.

1. AI, BI, AO and low voltage BO wires shall be routed uniformly in a singular bundle or through a single conduit.

a. Singular or multiple 120 volt BO wires shall be routed uniformly in a singular bundle or through a single conduit. High voltage (120 volt) BO wiring shall not be installed in the same bundle or conduit as AI, BI, or AO wiring unless otherwise specified.

b. Network wiring in exposed areas shall be installed in a conduit with no other wiring.

c. All conduit shall be EMT to within 3 feet of the device. Within 3 feet, flexible conduit may be employed. All conduit shall be supported from the building structure and should not lay on the ceiling.

d. All wiring and conduit shall be run either parallel or perpendicular to walls constructed in the area served. All takeoffs or junctions shall be made at 90 degree angles.

e. Pull strings shall be provided in all conduits for the future addition of wires.

f. Provide wire identification tags (using terminal numbers) in all DCP's and DTC's panels designating terminal connection points so that wiring between the panel and the sensing/control device can be easily identified. Tab 2 shows the Owner's approved scheme for panel and equipment identification.

g. All wiring in mechanical rooms shall be in conduit.

h. Low voltage and analog wiring shall be a minimum of 18 gauge twisted shielded pair.

i. 120 volt wiring shall be a minimum of 16 gauge twisted pair for relays or status wiring.

j. Communication wiring shall be Cat 5e UTP (Avaya 2061) or equal.

k. All sensors mounted in wall must have conduit stubbed to above wall.

2. The requirements concerning wire and conduit installation may also be found elsewhere in the specification and drawings.

D. The LCC contractor shall install 20 p.s.i. clean, pneumatic supply air to all airflow control valves.

E. The LCC contractor shall install, terminate and connect all cables as required. The LCC Contractor shall furnish all cable and connectors.

F. Linearized airflow control valves shall be installed in the duct-work by the mechanical contractor. All transitions and insulation shall be furnished and installed by the mechanical contractor. Airflow valves to be installed in supply air ductwork shall be furnished with closed cell foam insulation cut to fit around the valve and it's controller. It shall be the responsibility of the mechanical contractor to install the valves with the controllers positioned in an accessible location for set-up and maintenance.

G. The LCC shall provide properly sized reheat coil control valves to the mechanical contractor for installation. The Mechanical Contractor shall provide all necessary transition ductwork required for reheat coils. If the LCC requires flow meters, the LCC shall provide all necessary transition ductwork as required for installation to the sheetmetal contractor.

H. The LCC Contractor shall mount and wire all temperature controls associated with the reheat coils within the laboratory.

I. The LCC Contractor shall provide properly sized reheat coils for each supply air branch in an individual laboratory space shown on the plans. These coils shall be turned over to the Mechanical Contractor for mounting in the ductwork.

J. The BAS Contractor shall provide all interface wiring from the Lab Control system to the BAS System for monitoring and alarming.

K. System start-up shall be provided by a factory authorized representative of the laboratory airflow controls manufacturer. Said start-up shall include setting of the fume hood face velocity and electronic verification of supply, make-up, general exhaust, and return airflows. The balancing contractor shall be responsible for final verification and reporting of all airflows. It is the responsibility of the LCC to provide a factory certified start-up technician to work in conjunction with the test and balance contractor during the balancing phase of the project.

L. The laboratory airflow control system manufacturer shall furnish a minimum quantity of four (4), four(4) hour classes for ten (10) personnel at a time for a total of forty (40) personnel (sixteen (16), 4 hour classes) of owner training to provide an overview of the job specific airflow control components, calibration procedures in resetting fume hood velocities, general procedures for verifying airflows of air valves, and general troubleshooting procedures. Class shall be as scheduled by the Owner. Class dates shall not be consecutive.

6.12 LABORATORY WITH GENERAL EXHAUST TRACKING SUPPLY AIR

A. General

1. Each lab space shall be provided with a LCU for connection and control of the following:

    a. Supply Air Valve

    b. Space Temperature

    c. Supply Discharge Temperature

    d. Reheat Coil Valve

    e. General Exhaust Air Valve

    f. Room Emergency Override

    g. Network connection to the space's Digital Valves

    h. Network connection to other LCU's and the Interface Gateway

2. Each Supply Air Valve will be a Digital valve of the appropriate size configured for control through the LCU and connection to a virtual node general exhaust valve.

3. Each General Exhaust Air Valve will be a Vitrual Node valve of the appropriate size configured for connection to the Supply Digital Valve.

B. VOLUMETRIC TRACKING – The system shall measure the flow feedback of all supply air and exhaust air devices in the space. The general exhaust air valve shall be controlled to track a constant differential volume from the total space supply at all times. The volume offset shall return to within +/- 10% of setpoint within one second of any change in required flow from any of the variable volume devices in the lab space.

C. THERMAL LOAD CONTROL – The system shall measure the temperature in the space and the supply discharge duct. The system shall use these temperatures along with the supply airflow feedback to calculate the space's thermal load in BTUs/hr. The system shall use this value in an anticipatory manner to control the cooling supply air or reheat coil valve in order to maintain a stable space temperature at all times regardless of changes in room exhaust volume. The space temperature sensor shall have a user adjustable slide switch to raise or lower the space temperature setpoint within set limits. The space temperature sensor shall incorporate a local LCD readout of current temperature.

D. VENTILATION CONTROL – The supply air shall be controlled such that fresh air volume is maintained at or above the amount required to achieve the desired air change rate. The supply minimum flow shall be equal to the volume of the lab space times the number of desired (adjustable) changes per hour.

E. OCCUPIED / UNOCCUPIED CONTROL – Interface to the space occupancy sensors that shall be used to determine occupied / unoccupied for in each lab space. When the lab is unoccupied the current required air change rate to the unoccupied (adjustable) minimum value. Upon detection of personnel returning to the lab (via movement of a fume hood sash) the system lab shall immediately restore the air change rate setpoint to the occupied setpoint (adjustable). In addition the system shall allow the space temperature to float within a wider (adjustable) band before initiating a call for cooling or heating between and adjustable deadband.

F. EMERGENCY OVERRIDE – Each lab space shall be equipped with a jumbo pushbutton, maintained contact, emergency override switch at each exit of each lab. Upon sensing a depression of this switch the system shall place all variable flow devices to their programmed emergency flow setpoints. Each variable volume device's emergency flow setpoint shall be user programmable to accommodate the particular containment requirements of the space (either positive or negative).

G. CONSTANT VOLUME EXHAUST – Some spaces are equipped with Biological Safety Cabinets, Canopy Hoods, and or Spot Exhaust devices (i.e. flexible snorkels, slot exhaust, equipment exhaust). Each of these pieces of equipment shall be provided with a constant volume exhaust valve set for the appropriate flow. Each of these constant volume exhaust valves shall provide

flow feedback for connection to the laboratory controller to be used in calculating volumetric offsets and / or monitoring.

H. Laboratory with Fume Hood(s)

1. General

a. Each fume hood will be equipped with the following:

1) Fume Hood Operator Monitor.

2) Fume Hood Sash Sensor for a single vertical rising sash.

3) A Venturi or Bladder Exhaust Valve of the appropriate size configured for hood control.

b. Each Supply / Make-up Air valve will be a Venturi or Bladder valve of the appropriate size configured for control through the LCU and connection to a virtual node general exhaust valve.

c. Each General Exhaust Air Valve will be a Venturi or Bladder valve of the appropriate size configured for connection to the Supply Digital Valve.

2. Each lab space containing a fume hood shall be provided with a LCU for connection and control of the following:

a. Supply/Make-up Air Valve

b. Space Temperature

c. Supply Discharge Temperature

d. Reheat Coil Valve

e. General Exhaust Air Valve

f. Room Emergency Override

g. Network connection to the space's Digital Valves

h. Network connection to other LCU's and the BACNet™ Interface Gateway

I. Fume Hood Face Velocity Control

1. FACE VELOCITY CONTROL - The fume hood sash sensor shall be calibrated to a linear signal between minimum and maximum sash positions. The hood sash minimum shall be determined by calculating the sash area required to achieve the design face velocity at the required minimum flow volume plus three percent (3%) estimated leakage. When the sash has been lowered below this minimum area the hood shall function in a constant volume mode. When operating above this minimum position the fume hood monitor shall send a control signal to the digital hood exhaust valve proportional to the required exhaust flow to achieve the design face velocity. The fume hood monitor shall illuminate the normal operating status LED whenever the hood is operating in a normal state.

2. EMERGENCY OVERRIDE & ALARMS – A local emergency override button shall be part of the fume hood monitor, this button shall be a maintained type contact. When an operator depresses this override button the hood shall be commanded to the maximum design flow for the particular size valve in the hood exhaust duct. The monitor shall also light the emergency override red LED and sound the audible alarm. The emergency override shall be cleared by the operator depressing the emergency override button a second time. The fume hood monitor shall generate a "Caution –Flow Alarm" state whenever the hood is not achieving the required flow. This alarm will consist of lighting the "Caution –Flow Alarm" red LED on the monitor and sounding an audible alarm. The "Caution – Flow Alarm" sequence shall be initiated by any of the following conditions:

a. Flow feedback is 5% more or less than flow command.

b. System pressure falls below the required amount.

c. The hood sash is raised above the maximum design height.

d. The audible alarm shall be capable of being silenced by the operator depressing the "Mute" button on the hood monitor. Once an alarm has been muted any subsequent alarms shall re-engage the audible alarm.

3. NIGHT ENERGY WASTE – The fume hood monitor shall monitor the position of the fume hood sash and the light level in the space. Upon a condition of the lighting being below the adjustable setpoint and the sash being above the adjustable setpoint the hood monitor shall light the yellow "Energy Waste Alert" LED and sound the audible alarm.

4. Zone Presence Sensor

a. For variable air volume (VAV) systems, a sash sensor shall be provided to measure the height of each vertically moving fume hood sash. A sash sensor shall also be provided for horizontal overlapping sashes. Control systems employing sidewall-mounted velocity sensors shall be unacceptable..

b. A presence and motion sensor shall be capable of determining an operator's presence in front of the hood by detecting the presences and/or motion of an operator, and command the laboratory airflow control system from an in-use operating face velocity (e.g., 100 fpm) to a standby velocity (e.g., 60 fpm) and vice versa.

1) The sensor shall define a detection zone that extends approximately 20" (50cm) from the front of the fume hood. If the sensor does not detect the presence and/or motion in its detection zone within five seconds, it shall command the system to the user-adjustable standby face velocity. When the sensor detects the presence and/or motion of an operator within the detection zone, it shall command the system to the in-use face velocity within 1.0 second.

2) The sensor shall have a control circuit that adapts to its specific surroundings and automatically adjusts for inanimate objects placed within its detection zone. It shall map the area into memory and, after a period of five minutes, nullify the image of the inanimate object and return to a standby mode. Operators shall enter and leave the zone with the unit automatically adjusting between in-use and standby modes. If the inanimate object is moved or taken out of the zone, the unit shall automatically re-map the area.

3) Wide area motion detectors (on the hood or room level) shall be unacceptable.

c. The airflow at the fume hood shall vary in a linear manner between two adjustable minimum and maximum flow set points to maintain a constant face velocity throughout this range. A minimum volume flow shall be set to assure flow through the fume hood even with the sash totally closed..

d. A fume hood monitor shall be provided to receive the sash sensor output and presence and/or motion signal. This same monitor shall generate an exhaust airflow control signal for the appropriate airflow control device in order to provide a constant average face velocity. Audible and separate visual alarms shall be provided for both flow alarm and emergency exhaust conditions.

5. VOLUMETRIC TRACKING – The system shall measure the flow feedback of all supply/make-up air and exhaust air devices in the space. The supply/make-up air valve shall be controlled to track a constant differential volume from the total space exhaust at

all times. If the thermal load in the space calls for a greater volume of supply than would be required for make-up air the general exhaust valve shall be controlled to maintain the desired offset. The volume offset shall return to within +/- 10% of setpoint within one second of any change in required flow from any of the variable volume devices in the lab space.

6. THERMAL LOAD CONTROL – The system shall measure the temperature in the space and the supply/make-up discharge duct. The system shall use these temperatures along with the supply/make-up airflow feedback to calculate the space's thermal load in BTUs/hr. The system shall use this value in an anticipatory manner to control the cooling supply air or reheat coil valve in order to maintain a stable space temperature at all times regardless of the frequent changes in room exhaust volume associated with opening and closing of the fume hood(s). The space temperature sensor shall have a user adjustable slide switch to raise or lower the space temperature setpoint within set limits. The space temperature sensor shall incorporate a local LCD readout of current temperature.

7. VENTILATION CONTROL – The supply/make-up air shall be controlled such that fresh air volume is maintained at or above the amount required to achieve the desired air change rate. The supply minimum flow shall be equal to the volume of the lab space times the number of desired (adjustable) changes per hour.

8. OCCUPIED / UNOCCUPIED CONTROL – Two ceiling mounted room occupancy sensors shall be installed in each lab space. When the system senses that the lab is unoccupied and after an adjustable time delay the system shall reduce the current required air change rate to the unoccupied (adjustable) minimum value. Upon detection of personnel returning to the lab the system shall immediately restore the air change rate setpoint to the occupied setpoint (adjustable). The system shall also use the occupancy sensor to turn off the normal lighting in the space when the space has been unoccupied for the adjustable time period. In addition the system shall allow the space temperature to float within a wider (adjustable) band before initiating a call for cooling or heating.

9. EMERGENCY OVERRIDE – Each lab space shall be equipped with a jumbo pushbutton, maintained contact, emergency override switch at the exit of each lab. Upon sensing a depression of this switch the system shall place all variable flow devices to their programmed emergency flow setpoints. Each variable volume device's emergency flow setpoint shall be user programmable to accommodate the particular containment requirements of the space (either positive or negative).

10. CONSTANT VOLUME EXHAUST – Some spaces are equipped with Biological Safety Cabinets, Canopy Hoods, and or Spot Exhaust devices (i.e. flexible snorkels, equipment exhaust). Each of these pieces of equipment shall be provided with a constant volume exhaust valve set for the appropriate flow. Each of these constant volume exhaust valves shall provide flow feedback for connection to the laboratory controller to be used in calculating volumetric offsets and / or monitoring.

6.13 LABORATORY CONTROL SYSTEM BACNET™ INTERFACE POINTS AVAILABLE VIA THE BAS

A. The following points shall be available, as a minimum, through the BAS BACnet™ interface with the Laboratory Airflow / Temperature Control System.

B. For each Laboratory Zone:

1. Description	Point Type	Function
Space Temperature	Analog Input	BAS Read from LCS
Space Temperature Setpoint Adjust	Analog Input	BAS Read from LCS
Occupied Temperature Setpoint	Analog Output	BAS Write to LCS
Unoccupied Cooling Temperature Setpoint	Analog Output	BAS Write to LCS
Unoccupied Heating Temperature Setpoint	Analog Output	BAS Write to LCS

Supply Duct Discharge Air Temperature	Analog Input	BAS Read from LCS
Emergency Override Panic Button	Binary Input	BAS Read from LCS
Zone Offset CFM	Analog Input	BAS Read from LCS
Zone Offset CFM Setpoint	Analog Input	BAS Read from LCS
Zone Schedule Status	Binary Output	BAS Write to LCS
Supply / Make-up Air Flow	Analog Input	BAS Read from LCS
Supply / Make-up Air Flow Setpoint	Analog Input	BAS Read from LCS
Supply / Make-up Air Flow Alarm	Binary Input	BAS Read from LCS
Supply / Make-up Air Flow Occ Min Set	Analog Output	BAS Write to LCS
Supply / Make-up Air Flow Unocc Min Set	Analog Output	BAS Write to LCS
Cooling Demand %	Analog Input	BAS Read from LCS
Heating Demand %	Analog Input	BAS Read from LCS
General Exhaust Air Flow	Analog Input	BAS Read from LCS
General Exhaust Air Flow Setpoint	Analog Input	BAS Read from LCS
General Exhaust Air Flow Alarm	Binary Input	BAS Read from LCS

C. For each Fume Hood:

1. Description

	Point Type	Function
Space Temperature	Analog Input	BAS Read from LCS
Hood Face Velocity	Analog Input	BAS Read from LCS
Hood Face Velocity Setpoint	Analog Input	BAS Read from LCS
Hood Flow CFM	Analog Input	BAS Read from LCS
Hood Flow CFM Setpoint	Analog Input	BAS Read from LCS
Hood Flow Alarm	Binary Input	BAS Read from LCS
Hood Local Emergency Override Alarm	Binary Input	BAS Read from LCS
Hood Sash Opening %	Analog Input	BAS Read from LCS
Hood Sash Sensor Alarm	Binary Input	BAS Read from LCS
Hood Sash Opening Alarm Setpoint	Analog Output	BAS Write to LCS
Hood Sash Opening Alarm	Binary Input	BAS Read from LC
Hood Occupancy	Binary Input	BAS Read from LC

END OF SECTION 230900

N:\N0912.00\DOC\SPEC\2012_03-16_BID\230900_INSTRUMENTATION AND CONTROL.DOC

SECTION 230995 BUILDING AUTOMATION SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. BAS System and equipment testing and start-up

B. Validation of proper and thorough installation of BAS systems and equipment

C. Functional testing of control systems

D. Documentation of tests, procedures, and installations

E. Coordination of BAS training

F. Documentation of BAS Operation and Maintenance materials

1.2 GENERAL DESCRIPTION

A. This section defines responsibilities of the Building Automation System Contractor to Commission the BAS.

B. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

C. Commissioning Authority (CA) is retained by the Owner and shall work with the Contractor and the Design Engineer to direct and oversee the Commissioning process and perform functional performance testing.

D. This Section outlines the Commissioning procedures specific to the Building Automation System Contractors. Requirements common to all Sections are specified in Sections 019113 and 019114.

E. The scope of the Commissioning on this project shall include the entire BAS system.

1.3 RELATED SECTIONS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. The Cx process references many related Sections, particularly Section 019113 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 019113.

C. Refer to Section 019113 for a complete list of Sections on Related Work.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113.

1.5 REFERENCE STANDARDS

A. ASHRAE Guideline 1-1996, "Guideline for Commissioning HVAC Systems"

B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”

C. NEBB - Procedural Standards for Building Systems Commissioning

D. ASHRAE Standard 110 – Method for Testing Laboratory Fume Hoods

E. USGBC - LEED NC 3.0 Reference Package

1.6 CONTRACTOR RESPONSIBILITIES

A. General responsibilities of the Contractor are specified in Section 019113. The following responsibilities indicate specific responsibilities of the BAS contractor in addition to those responsibilities

B. Assist CA in verification and performance testing. Assistance will generally include the following:

1. Establish trend logs of system operation as specified herein
2. Manipulate systems and equipment to facilitate functional performance testing as outlined in Section 019114.
3. Provide Portable Operators Terminals or operator workstations in locations convenient to testing activities as specified below
4. Provide CA with appropriate passwords, keys, and access to control panels and workstations.
5. Where control systems do not allow a test mode or the overriding of physical input values for testing, program an interim virtual point for all inputs that can be used to represent the point and be overridden for testing

C. Provide a Control technician to work at the direction of Commissioning Authority for software optimization assistance for a minimum of 16 hours. Refer to Part 3 for a description of the software optimization.

D. Provide a form summarizing all setpoints and alarm parameters and alarming strategies for the Owner to complete. Organize a meeting with Owner and CA to discuss the desired initial setpoints and alarm parameters. Contractor shall enter the requested setpoints and alarm parameters at completion of start up and record the applicable settings in the prefunctional documentation.

E. Train Owner’s Representatives in systems operation and control equipment use, operation, maintenance and repair. Training shall be conducted as follows:

1. Control system training shall be conducted by the Control Subcontractor. Control system training shall be as specified in Part - 3 of this section.

F. Compensate the Owner for site time necessitated by incompleteness of systems or equipment at time of functional performance testing. All testing failures which require on-site time for retesting will be considered actual damages to the Owner. The contract sum shall be reduced by contract modification at a rate of $145 per man-hour of on-site time necessary to retest failures. All parties under contract with the Owner who are affected by the retesting shall be included in the contract modification. Refer to Section 019113 and 019114 for more details.

1.7 SEQUENCING:

A. Refer Section 019113.

B. The following list outlines the general sequence of events for Commissioning of the Control systems.

1. Construction Phase:

a. Collaborate on construction scheduling
b. Submit Product data and Shop Drawings, and receive approval.
c. Meet with Commissioning Team to coordinate with all trades
d. Submit Control Logic Documentation, and receive approval.
e. Begin controls installation.
f. Submit refinement of generic prefunctional checklists incorporating manufacture specific start-up procedures accompanied by manufacturers pre-printed start up procedures for all equipment provided by the BAS contractor
g. Receive BAS prefunctional checklists approval.
h. Submit Training Plan content
i. Receive approval of Training Plan content
j. Provide alarm list and receive approval
k. Provide sample graphics and receive approval
l. Complete BAS system installation
m. Place systems under BAS control.
n. Enter alarms as approved by Owner
o. Complete BAS graphics
p. Perform BAS system start up and complete prefunctional documentation.
q. Submit completed BAS prefunctional Checklists
r. Prepare and initiate Trend Log data storage and format trend graphs.
s. Train Owner on control system operation and maintenance for basic system offering.
t. Formal Hand off Meeting
u. Submit Commissioning BAS Software/Access and provide technician level (monitoring, point override/test, and setpoint adjustment) password access to Owner and CA.
v. Receive BAS prefunctional documentation approval and approval to schedule Commissioning Demonstrations.
w. Demonstrate systems to Commissioning Authority and Owner.
x. Submit trend logs in format specified
y. Receive Demonstration approval and approval to schedule Acceptance Phase.

2. Acceptance Phase

a. Receive Operational Test approval which enables start of Functional Testing.
b. CA Performs Functional Performance Testing and BAS contractor participates in initial samples.
c. Two week Operational Test
d. Receive Functional Completion approval for the BAS.
e. Substantial Completion

3. Warranty Phase

a. Provide administrator password access to Owner.
b. Train Owner on final Sequences and modes of operation.
c. Update facility manual content with any changes.
d. Revise and Re-Submit Record drawings and O&M manuals.
e. Install Framed Control Drawings

f. Final Completion
g. Opposite Season Operational Test and Functional Performance Testing
h. Receive Opposite Season Operational Test and FPT approval
i. Revise and Re-Submit Record drawings and O&M manuals and update framed control drawings if any changes result from opposite season operational test.
j. Complete owner training.
k. End of Warranty Period

1.8 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:

1. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of + or - 0.1°F.
2. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
3. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CA.

C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

2.3 TAB & COMMISSIONING PORTABLE OPERATORS TERMINAL

A. Provide the CA with all software, connection devices, licenses, passwords and the like to facilitate connection to the BAS throughout the building. Provide a license to graphic software, and all operating software necessary for testing and configuration of all control elements at all levels. License may be a temporary license that will expire after the completion of the Warranty Period. Options include:

1. Browser access to the full graphic software; CA will provide laptop however BAS contractor shall set up the laptop to successfully connect.
2. Licensed Client Software to be installed on CA Computer; BAS contractor shall install the software and ensure it is functional.

B. Access to the BAS must be provided throughout the building as more fully defined as follows:

1. Full wireless connection to the graphic server throughout the building will be adequate.
2. Network connection for full access to the graphic server within 50' of any point in the building
3. Exception to 1 and 2 above: an acceptable alternative to full building access to the graphic server relating to terminal controls shall be providing to the CA the devices and software required to connect to local terminal controllers through a connection port in the space such as connection to a jack on the temperature sensor (basically what is required by TAB specified below). This does not apply to mechanical rooms as full graphic access is required in mechanical rooms.

C. Provide software required by TAB to calibrate all flow sensors. TAB will provide computer to be used as a portable operator's terminal. Any manufacturer specific hardware such as connection cables, converters, hand held devices, etc. shall be provided by the contractor.

D. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor as well as at the box. Otherwise a wireless system shall be provided to facilitate this local functionality.

PART 3 - EXECUTION

3.1 BAS START-UP TESTING, ADJUSTING, CALIBRATION

A. Work and/or systems installed shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:

1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
3. Verify integrity/safety of all electrical connections.
4. Coordinate with TAB subcontractor to obtain and CA to fine tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS Start-Up Report:

a. Optimum duct static pressure setpoints for VAV air handling units
b. Minimum outside air damper settings for air handling units
c. Optimum differential pressure setpoints for variable speed pumping systems.
d. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.

1) BAS contractor shall provide hand held device as a minimum to the TAB and CA to facilitate calibration. Connection for any given device shall local to it (at the VAV box or at the thermostat). HHD or portable operators' terminal shall allow querying and editing of parameters required for proper calibration and start up.

e. Calibration parameters for fume hoods

5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start up Report.
6. Check and set zero and span adjustments for all transducers and transmitters.
7. For dampers and valves:

   a. Check for adequate installation including free travel throughout range and adequate seal.
   b. Where loops are sequenced, check for proper control without overlap

8. For actuators:

   a. Check to insure that device seals tightly when the appropriate signal is applied to the operator.
   b. Check for appropriate fail position, and that the stroke and range is as required and coordinated with the programmed ranges when it is operating under normal conditions.
   c. For pneumatic operators, adjust the operator spring compression as required to achieve close off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split range positioners to verify proper operation. Record settings for each device.
   d. Check the stroke and range under actual loading conditions and validate that they correlate with programmed values
   e. For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.

9. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device.
10. For outputs to reset other manufacturers devices (VFDs) and feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
11. Verify proper sequences by using the approved checklists to record results. Verify proper sequence and operation of all specified functions.
12. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
13. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start up Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):

    a. Duct air temperature: ±1°F.
    b. Space Temperature: ±3°F within 3 minutes and control within ±2°F

c. Chilled Water: ±1°F
d. Hot water temperature: ±2°F.
e. Duct pressure: ± 0.25" w.c.
f. Water pressure: ±1 psid
g. Duct Humidity: ±3% when adding humidity
h. Space Humidity: ±5% when adding humidity to control
i. Terminal Air flow control: ±5% of setpoint. This includes all VAV terminal control and exhausted BSCs, canopy hoods, ventilated cage racks, necropsy tables, and other scientific equipment with supply or exhaust ventilation
j. Fume Hoods: ±10% on full sash travel (from min to max in 3 seconds) within 3 seconds. ±5% when sash is positioned in the controllable range. Refer to Section 15995 for fume hood acceptance requirements
k. Space Pressurization (on active control systems): ±0.03" w.c. with no door or window movements. No high containment space shall go more than 0.15" w.c. positive, nor go positive at all for more than 20 seconds.

14. For communication interfaces and DDC control panels:

    a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
    b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
    c. Check power supplies for proper voltage ranges and loading.
    d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
    e. Check for adequate signal strength and acceptable bandwidth utilization on communication networks.
    f. Check for stand alone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at OIs. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
    g. Ensure that all outputs and devices fail to their proper positions/states.
    h. Ensure that buffered and/or volatile information is held through power outage
    i. With all system and communications operating normally and all trends functioning, sample and record update/annunciation times for critical alarms fed from the panel to the OI.
    j. Check for adequate grounding of all DDC panels and devices.
    k. Run self diagnostic routines and ensure they are functional
    l. Check the memory allocation and loading to ensure adequate and excess capacity is available and that it will not affect control functionality.

15. Coordinate desired initial alarm strategies with Owner's Operators. Set all required alarms and document the initial settings in the start up documentation
16. Coordinate all initial setpoints with Owner's Operators. Ensure those setpoints are active
17. For Operator Interfaces:

    a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
    b. Output all specified BAS reports for review and approval.
    c. Verify that the alarm printing and logging is functional and per requirements.
    d. Verify that trend archiving to disk and provide a sample to the CA for review.
    e. Verify alarm enunciation functionality. Time delay from actual occurrence to the time updated or enunciated on the screen. Ensure it is per the specified requirements.
    f. Verify that real time and historical trends are accessible and viewable in graph format.
    g. Verify that paging/dial out alarm annunciation is functional.

h. Verify the functionality of remote OIs and that a robust connection can be established consistently.
i. Verify that required third party software applications required with the bid are installed and are functional.
j. Demonstrate open protocol and custom third party interfaces reliably communicate and check response time.
k. Verify response times and screen update and refresh times are per the requirements.
l. Verify that all custom programs are editable from the OI. Check upload, download, back up and restore capabilities of system configuration information as well as custom programs.
m. Verify schedules are set up and working.
n. Verify Owner stipulated security and permissions is set up and functional.
o. In concert with the Building Power Outage test, validate that critical GUI installations are properly powered by UPS and emergency outlets to keep it functional during a power outage. Validate that the space has adequate lighting to manage the building in the event of an outage.

18. Start up and check out control air compressors and air drying and filtering systems in accordance with the appropriate section and with manufacturer's instructions.

a. Validate adequate deliver and pressures
b. Validate adequate redundancy
c. Validate max run time and cycle time vs. manufacturer's recommendations
d. Validate that routing of the compressed air does not result in condensation at any point in the system when used with the specified drier
e. Check all PRVs both primary and back up to ensure adequate functionality and maintenance of downstream pressure

19. Verify proper interface with fire alarm system.
20. Verify proper interface with control panels of equipment with self contained controls that are being monitored by the BAS.

B. Submit Start-Up/prefunctional Documentation. This shall be completed, submitted, and approved prior to demonstration and Acceptance Phase.

3.2 SENSOR CHECKOUT AND CALIBRATION

A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.

B. Calibration: Calibrate all sensors using one of the following procedures:

1. Sensors without Transmitters--Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or EMCS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
2. Sensors with Transmitters--Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data simulate minimum desired

temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or EMCS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device.

3.3 LOOP TUNING

A. For all control loops, contractor shall tune the loops to ensure the fastest stable response without hunting, offset or overshoot with tolerances defined above. Contractor shall introduce upsets to the load when possible to affect response. Otherwise, setpoints can be changed to affect the response.

B. Generally tune loops during periods of high gain.

C. Document all parameters either by capturing text, short interval trends, or screen shots of trend graph documenting the final response.

3.4 COIL VALVE LEAK CHECK

A. Verify proper close off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via the OI, command the valve to close. Energize fans. After 5 minutes, observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.5 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the OI readout.

B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command valve to a few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics)

3.6 ALARM SETPOINT COORDINATION

A. The Contractor shall prepare a list of all conceptual point types and recommend the types and recommended alarming strategies and setpoint for review of Commissioning Agent and Owner. Owner shall use this alarm list to provide direction to Contractor for alarm strategies and setpoints. Alarm list shall be provided at least two months prior to the first functional test. Contractor shall have alarm setpoints entered prior to functional testing. Omitting an alarm setting, using the wrong strategy, or entering the wrong setpoints will be considered a failure from the perspective of the functional test.

3.7 GRAPHIC COORDINATION

A. The Contractor shall prepare all graphics (only one example graphic is required for typical systems like terminal units) with points embedded for review of Commissioning Agent and Owner. Owner shall use these graphics to provide direction to Contractor for the required final graphic. All final graphics must be complete and active before functional testing. Any deviation from the approved graphics will be considered a failure from the perspective of the functional test.

3.8 BAS DEMONSTRATION

A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Commissioning Agent and Owner. Schedule the demonstration with the Owner's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform to Contract specifications, so as to require scheduling of additional site visits by the Commissioning Authority for re-demonstration, Contractor shall reimburse Owner for costs of subsequent Commissioning Authority site visits.

B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.

C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner and CA.

D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:

1. Demonstrate that required software is installed on EMCS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.
4. Demonstrate correct calibration of input/output devices using the same methods specified for the start-Up tests. A maximum of 10 percent of I/O points shall be selected at random by Commissioning Authority and/or Owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by Commissioning Authority for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
5. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
6. Demonstrate that all DDC programs accomplish the specified sequences of operation.
7. Demonstrate that the panels automatically recover from power failures, as specified.
8. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
9. Identify access to equipment selected by Commissioning Authority. Demonstrate that access is sufficient to perform required maintenance.

10. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.

E. BAS Demonstration shall be completed and approved prior to functional testing.

F. Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be repeated.

3.9 FUNCTIONAL PERFORMANCE TESTING

A. Requirements for assistance with functional performance testing are specified in the Section 019114. Provide assistance during Functional Performance Testing per 019114 and related Specifications.

3.10 BAS ACCEPTANCE PERIOD

A. After approval of the BAS Demonstration and prior to Substantial Completion, Acceptance Phase shall commence. Acceptance Period shall not be scheduled until all HVAC systems are in operation and have been started and the startup documented, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, etc.), and draft TAB report has been submitted. Acceptance Period and its approval MAY be performed on a system-by-system basis if mutually agreed upon by contractor and Owner.

B. Operational Test: At the end of the Acceptance Phase, the system shall operate properly for two weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. At the end of the two weeks, contractor shall forward the trend logs to the CA for review. CA shall determine if the system is ready for functional acceptance and document any problems requiring contractor attention.

1. If the systems are not ready for functional acceptance, Contractor shall correct problems and provide notification to the Owner's representative that all problems have been corrected. The Operational Test shall be restarted at a mutually scheduled time for an additional one week period. This process shall be repeated until Commissioning Authority issues notice that the BAS is ready for functional acceptance.

C. During the Acceptance Period, the contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the contractor's opinion, the cause of the alarm is not the responsibility of the contractor, contractor shall immediately notify the Owner's representative.

D. During the Acceptance Phase, the contractor shall maintain all controller network and workstation hardware and software in a state that will allow remote access by Commissioning Agent to Trend Logs as specified below.

3.11 TREND LOGS

A. Trends are historical archives on computer disks that document the operation of the systems and equipment. Trends can be interval recordings of system I/O parameters or Change of Value based trends that record when a system value changes by more than a specified threshold.

B. CA will analyze trend logs of the system operating parameters to evaluate normal system functionality. The requirements of the trending are specified below. Contractor shall establish these trends, ensure they are being stored properly, and forward the data in electronic format to the CA.

C. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate two dimensional formats with time being the vertical axis and field name being the horizontal axis. Data shall be forwarded in one of the following formats.

1. Microsoft ACCESS Database (.mdb)
2. Microsoft EXCEL Spreadsheet (.xls)
3. Comma Separated Value (.csv or .txt) preferably with quotes delimiting text fields and # delimiting date/time fields

D. Sample times indicated as COV (±) or change of value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.

E. Contractor shall provide the CA with required passwords, phone numbers, etc. to allow the CA access to the trend log data and allow downloading to a remote location. Contractor shall also provide step-by-step written instructions for accessing the data.

F. Trending Requirements: All points on primary equipment and selected sampling of terminal points unless approved otherwise. This will include, but not be limited to the following. At a minimum, trend the following on 10 min. intervals for analog values and change of value for binary values.

1. Outside Air Temperature
2. Outside Air Enthalpy
3. Cooling Tons
4. All sensed Hydronic Temperatures
5. All sensed air temperatures on primary equipment
6. All damper outputs on primary equipment
7. All valve outputs on primary equipment
8. All sensed Fan Volumes on primary equipment
9. All inputs and outputs to VFDs
10. Return (or exhaust) Air Temperature on each air handler
11. All safety indications
12. Status on all primary equipment
13. All air and water pressures on primary equipment or systems
14. Space Temperatures
15. Steam Flow
16. Electricity consumption where monitored.
17. Natural Gas flows
18. Converter steam valves and hot water temperatures
19. Steam supply pressures and temperatures.
20. Basically all points on primary equipment and selected sampling of terminal points unless approved otherwise

G. Trending to document functional tests may typically be at a more frequent interval. Consult with the CA to determine the required intervals for functional testing and modify intervals as required.

3.12 TREND GRAPHS

A. Trend graphs shall generally be used during the Acceptance Phase to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the Acceptance

Period. Trend graphs shall demonstrate compliance with contract documents. Trended values and intervals shall be the same as those specified for the functional performance tests.

B. Contractor shall establish trend graphs for every PID loop under control for the main equipment and for the terminal zones, which shows the input, output and setpoint. Where applicable, multiple graphs can be used to clearly display the data. Also, multiple PIDs can share a graph when there is correlation, such as an AHU temperature and setpoint and valve outputs for both the HW and CHW valve. Coordinate with the CA regarding the set-up of the trend summaries.

C. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.

D. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.c., Btu/lb, percent wide open, etc.

E. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

F. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.

G. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period.

H. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

3.13 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING

A. Trending: throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Period. Contractor shall forward archived trend logs to the CA for review upon CA's request. CA will review these and notify contractor of any warranty work required.

B. Opposite Season Testing: Within 6 months of completion of the Acceptance Phase, CA shall schedule and conduct Opposite Season functional performance testing. Contractor shall support this testing and remedy any deficiencies identified.

3.14 SOFTWARE OPTIMIZATION ASSISTANCE

A. The contractor shall provide the services of a controls technician as specified above at the project site to be at the disposal of the CA. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the CA during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be included with the bid. Requests for assistance shall be for contiguous or non-contiguous 8 hour days, unless otherwise mutually agreed upon by contractor, Commissioning Authority, and Owner. The Owner's representative shall notify contractor 2 days in advance of each day of requested assistance.

B. The controls technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the controls technician provided cannot perform every software task requested by the Commissioning Authority in a timely fashion, contractor shall provide additional qualified personnel at the project site as requested by the Commissioning Authority, to meet the total specified requirement on-site.

3.15 BAS OPERATOR TRAINING

A. Provide up to 6 complete sets of User Manuals (hard copy and one electronic copy) to be used for training.

B. Contractor shall submit a Training Plan per the requirements of Div 1 for the scope of training he is responsible. Training Plan shall be forwarded to the CM who will forward it to the AE and CA for review.

C. On Site Training: Provide training as specified and as supplemented below. All training shall include the appropriate training materials and attendance documentation required by Div1.

D. BAS Final Systems Operation Training

1. The BAS shall participate a session to present the final sequences programmed into the control system. The session will basically present:

   a. Control System Architecture
   b. Addressing and location of panels
   c. Schematic configuration of the systems
   d. Final programmed sequences. It shall present the written sequences and illustrate the programming that accomplishes those sequences. This session is typically presented on site by the primary BAS technician that managed the installation of the controls at that facility.

2. The BAS shall be use the Record Control Shop Drawings as the handout for the training. The audience for the session will be the Owner's operators and managers. The setting should be primarily classroom. Since the presentation will typically need to use a live Operator Interface, BAS shall work out the logistics of projecting the video for an effective presentation.

END OF SECTION 230995

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Condenser-water piping.
   4. Glycol cooling-water piping.
   5. Makeup-water piping.
   6. Condensate-drain piping.
   7. Air-vent piping.
   8. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:
   1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Hot-Water Heating Piping: 150 psig at 200 deg F.
   2. Chilled-Water Piping: 150 psig at 200 deg F.
   3. Condenser-Water Piping: 150 psig at 150 deg F.
   4. Glycol Cooling-Water Piping: 150 psig at 150 deg F.
   5. Makeup-Water Piping: 80 psig at 150 deg F.
   6. Condensate-Drain Piping: 100 deg F.
   7. Air-Vent Piping: 100 psig at 150 deg F.
   8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Chemical treatment.
4. Hydronic specialties.

B. LEED Submittal:
1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Refer to Section 23 0000 – "Basic HVAC Requirements" for coordination drawing requirements.

D. Welding certificates.

E. Qualification Data: For Installer.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

H. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. DWV Copper Tubing: ASTM B 306.

C. Wrought-Copper Fittings: ASME B16.22.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. S. P. Fittings; a division of Star Pipe Products.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.
2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Victaulic Company of America.
2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 VALVES

A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Tour and Anderson.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Plastic dial, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Tour & Anderson; available through Victaulic Company of America.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Plastic dial, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.

11. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Spence Engineering Company, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Spence Engineering Company, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flow Design Inc.
   b. Griswold Controls.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bonze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.

2.6 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.
5. Spiro-Therm

B. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:
1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Bladder-Type Expansion Tanks:
1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Tangential-Type Air Separators:
1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

F. Air and Dirt Separators:

1. Tank: Welded steel; ASME constructed and labeled for 150-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.

2. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
3. Description: Coalescing type air eliminator and dirt separator, entering velocities not to exceed 4 feet per second at specified GPM, include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency, consisting of a copper core tube with continuous wound copper medium permanently affixed to the core. Separate copper medium wound completely around and permanently affixed to the internal element, separate venting chamber to prevent system contaminants from harming the float and venting valve operation, venting chamber shall be an integral full port float actuated brass venting mechanism, valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill, capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid. Dirt separation shall be at least 80% of all particles 30 micron and larger within 100 passes.
4. Manufacturer: Spiro-Therm.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [**40**] [**60**]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.
6. Provide for pump suction and discharge piping 4-inch or smaller.

C. Spherical, Rubber, Flexible Connectors:
1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.
6. Provide for pump suction and discharge piping 5-inch and larger.

D. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be the following:
   1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:
   1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Condenser-water piping, aboveground, NPS 2-inch and smaller, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

F. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:
   1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

G. Makeup-water piping installed aboveground shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

H. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

I. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

J. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

K. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

P. Install unions in piping**,** NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

S. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
7. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. NPS 3-1/2: Maximum span, 13 feet; minimum rod size, 1/2 inch.
9. NPS 4: Maximum span, 14 feet; minimum rod size, 5/8 inch.
10. NPS 5: Maximum span, 16 feet; minimum rod size, 5/8 inch.
11. NPS 6: Maximum span, 17 feet; minimum rod size, 3/4 inch.
12. NPS 8: Maximum span, 19 feet; minimum rod size, 3/4 inch.
13. NPS 10: Maximum span, 22 feet; minimum rod size, 7/8 inch.
14. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.

D. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator to expansion tank with a 2 percent upward slope toward tank.

D. Install tangential air separator in pump suction. Install blowdown piping with butterfly or full-port ball valve; extend full size to nearest floor drain.

E. Install bypass chemical feeders in each closed hydronic systems and where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

1. By-pass chemical feeder shall not be used for glycol charging.

F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.8 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
   1. pH: 9.0 to 10.5.
   2. "P" Alkalinity: 100 to 500 ppm.
   3. Boron: 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
   5. Corrosion Inhibitor:
      a. Sodium Nitrate: 1000 to 1500 ppm.
      b. Molybdate: 200 to 300 ppm.
      c. Chromate: 200 to 300 ppm.
      d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
      e. Chromate Plus Molybdate: 50 to 100 ppm each.
   6. Soluble Copper: Maximum 0.20 ppm.
   7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
   8. Total Suspended Solids: Maximum 10 ppm.
   9. Ammonia: Maximum 20 ppm.
   10. Free Caustic Alkalinity: Maximum 20 ppm.
   11. Microbiological Limits:
      a. Total Aerobic Plate Count: Maximum 1000 organisms/ml.
      b. Total Anaerobic Plate Count: Maximum 100 organisms/ml.
      c. Nitrate Reducers: 100 organisms/ml.
      d. Sulfate Reducers: Maximum 0 organisms/ml.
      e. Iron Bacteria: Maximum 0 organisms/ml.

B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

C. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

D. Fill systems indicated to have glycol solutions with the following concentrations:
   1. Glycol Cooling-Water Piping: Minimum 30 percent propylene glycol, see Section 236513 – “Glycol Heat Transfer Fluid”.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

N:\N0912.00\DOC\SPEC\2012_03-16_BID\232113 - HYDRONIC PIPING.DOC

SECTION 232114 – PRE-INSULATED UNDERGROUND HVAC PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section describes prefabricated insulated pipe/ conduit systems.

1.2 SUBMITTALS

A. Submit for review:
   1. Product data, including materials of construction of all parts and their arrangement.
   2. Provide site drawing detailing installation, showing all fittings, manholes, expansion loops, anchors, guides, concrete thrust blocks, valves, etc.
   3. Anchors, expansion loops and guide calculations and design stamped by a registered engineer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials to prevent damage. End covers shall be repaired or replaced to prevent entry of water.

B. Seal ends of conduits.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Thermacor

B. Rovanco

C. Permapipe

2.2 UNDERGROUND CHILLED AND HOT WATER PIPING SYSTEMS

A. Carrier Pipe:
   1. Black steel schedule 40 for underground chilled and hot water piping.

B. Insulation: Polyurethane foam with the following characteristics:
   1. Thermal conductivity "K" 0.20 btu-in/hr.-ft²-°f
   2. Density: 2 pcf.
   3. Closed Cell Content: 90-95% in conformance with ASTM C-591 completely filling the annular space between carrier pipe and jacketing.
   4. The insulation thickness shall be nominal 1-inch minimum.

C. Jacketing Material: Extruded, black, high-density polyethylene (HDPE), manufactured in accordance with ASTM D-1248 having a minimum wall thickness of 125 mils and meeting the specifications shown below:

Specific Gravity (ASTM D792)	0.941 min.
Impact Strength (ASTM D256)	Ft. Lb./in. notch, 2.0 min
Tensile Strength (ASTM D638)	3100 psi min.
Hardness, Shored (ASTM D785)	60 min.
Elongation Ultimate (ASTM D638)	400% min.
Compressive Strength (ASTM D695)	2700 psi min.
Resistance to Heat, Continuous:	
Vicat Softening Temperature (ASTM D 1525)	250°F min.

TABLE 4

NOMINAL CARRIER PIPE DIAMETER (Inches)	JACKET THICKNESS (Inches)
3/4	0.060
12	0.150

D. Carrier Pipe Joining Method: Welded joints and welded flanged fittings for steel chilled water pipes and heating hot water piping.

E. Fittings: Insulated and jacketed to match adjacent piping.

F. Insulation of Straight Joints: After welding and testing insulate and seal and all joints with factory supplied joining kits.

G. Anchors: Attach a ½" thick steel anchor plate to the carrier pipe and seal it to the pipe jacketing.

PART 3 - EXECUTION

3.1 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

A. Provide as specified in Section 15075.

3.2 INSTALLATION

A. Install all pre-insulated underground piping systems in accordance with manufacturer's installation instructions and details, and under the supervision of the manufacturer's field service technician or representative.

3.3 FIELD HYDROSTATIC PRESSURE TESTING

A. All Underground Piping Systems: As specified in SECTION 15060.

B. Document all pipe testing per the forms, procedures and protocols outlined in the commissioning requirements.

3.4 BUILDING, MANHOLE OR VAULT ENTRIES

A. Seal with wall sleeves and pipe seals for water-exposed, non-flashed construction as specified in SECTION 15050.

3.5 TRENCH AND BACKFILL

A. Trench:
   1. Trench width shall be not less than 18" wider than the combined O.D. of all piping systems installed in the trench.
   2. If hard rock or shall is encountered, excavate trench 6" deeper than necessary, then fill with sand or gravel to act as a cushion.

B. Backfill: Tamped compactly in place to assure a stable surface. No rock shall be used in the first foot of backfill. 36" minimum, top of conduit to grade, of compacted fill shall meet H-20 Highway Loading.

3.6 MANUFACTURER'S FIELD SERVICE

A. A factory trained, full-time employee of the manufacturer shall be present on site for unloading of pipe, placing of pipe in trench, hydrostatic and air testing and placement of pipe anchors.

END OF SECTION 232114

N:\N0912.00\DOC\SPEC\2012_03-16_BID\232114 - PRE-INSULATED UNDERGROUND HVAC PIPING SYSTEMS.DOC

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Close-coupled, in-line centrifugal pumps.
   2. Separately coupled, horizontal, in-line centrifugal pumps.
   3. Separately coupled, vertical, in-line centrifugal pumps.
   4. Separately coupled, base-mounted, end-suction centrifugal pumps.
   5. Separately coupled, base-mounted, double-suction centrifugal pumps.
   6. Automatic condensate pump units.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
1. Bell & Gossett; Div. of ITT Industries.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted

horizontally or vertically. Rate pump for 250-psig minimum working pressure and a continuous water temperature of 250 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

E. Capacities and Characteristics: As scheduled on plans.

2.3 SEPARATELY COUPLED, HORIZONTAL, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
1. Bell & Gossett; Div. of ITT Industries.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 250 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

D. Shaft Coupling: Molded rubber insert with interlocking spider capable of absorbing vibration.

E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and resiliently mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

F. Capacities and Characteristics: As scheduled on plans.

2.4 SEPARATELY COUPLED, VERTICAL, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
1. Bell & Gossett; Div. of ITT Industries.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 250-psig minimum working pressure and a continuous water temperature of 250 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Permanently lubricated ball bearings.

D. Shaft Coupling: Axially split spacer coupling.

E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

F. Capacities and Characteristics: As scheduled on plans.

2.5 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
1. Bell & Gossett; Div. of ITT Industries.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 250-psig minimum working pressure and a continuous water temperature of 250 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.

5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Capacities and Characteristics: As scheduled on plans.

2.6 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers:
1. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.

B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- minimum, electrical power cord with plug.

2.7 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 300-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 300-psig pressure rating, ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Common Work Results for HVAC."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight.

F. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
   2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

G. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation and HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install Y-type strainer and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

I. Install check valve and gate or ball valve on each condensate pump unit discharge.

J. Install electrical connections for power, controls, and devices.

K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.

4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 232123

N:\N0912.00\DOC\SPEC\2012_03-16_BID\232123 - HYDRONIC PUMPS.DOC

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:
   1. Suction Lines for Air-Conditioning Applications: 185 psig.
   2. Hot-Gas and Liquid Lines: 325 psig.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Filter dryers.
   4. Strainers.
   5. Pressure-regulating valves.

B. Welding certificates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.

7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:
1. Body: Forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 208-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Nonadjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

H. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.

2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

I. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:
1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 5 tons.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 5 tons.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

M. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.

4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-22: Monochlorodifluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-134a

A. Hot-Gas, Liquid Lines, and Suction Lines:
1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Safety-Relief-Valve Discharge Piping: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

C. Safety-Relief-Valve Discharge Piping:
1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install packed-angle valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install packed-angle valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
1. Solenoid valves.
2. Thermostatic expansion valves.
3. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in

Division 8 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:
1. Install horizontal suction lines with a uniform slope downward to compressor.
2. Install traps and double risers to entrain oil in vertical runs.
3. Liquid lines may be installed level.

O. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers according to Division 7 Section "Through-Penetration Firestop Systems."

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

U. Seal pipe penetrations through exterior walls according to Division 7 Section "Joint Sealants" for materials and methods.

V. Identify refrigerant piping and valves according to Division 23 Section "Mechanical Identification."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

E. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Verify that compressor oil level is correct.
   2. Open compressor suction and discharge valves.
   3. Open refrigerant valves except bypass valves that are used for other purposes.
   4. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

N:\N0912.00\DOC\SPEC\2012_03-16_BID\232300 - REFRIGERANT PIPING.DOC

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Double-wall rectangular ducts and fittings.
   3. Single-wall round and flat-oval ducts and fittings.
   4. Double-wall round and flat-oval ducts and fittings.
   5. Sheet metal materials.
   6. Duct liner.
   7. Sealants and gaskets.
   8. Hangers and supports.

B. Related Sections:
   1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.

B. LEED Submittals:
   1. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."
   2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."
   3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1-2004, Section 6.4.4.2.2 - "Duct Leakage Tests."
   4. Duct-Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1-2004, Section 7.2.4 - "Ventilation System Start-Up."

5. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout (scale = 1/4" – 1'-0") indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

D. Coordination Drawings: Plans, drawn to scale(scale = 1/4" – 1'-0"), on which the following items are shown and coordinated with each other, using input from installers of the items involved. Refer to Section 23 0000 – "Basic HVAC Requirements" for other coordination drawing requirements:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

E. Welding certificates.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. McGill AirFlow LLC.
2. Lindab, Inc.
3. Sheet Metal Connectors, Inc.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Two-inch thick for supply and one-inch thick for return fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.23 Btu x in./h x sq. ft. x deg F Insert conductivity at 75 deg F mean temperature.
   2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   3. Coat insulation with antimicrobial coating in ducts with perforated inner liners.

G. Inner Duct: Minimum 0.028-inch solid or perforated sheet steel as indicated on drawings or on schedule below.

H. Factory Fabricated Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Lindab Inc.
      b. McGill AirFlow LLC.
      c. SEMCO Incorporated.
      d. Sheet Metal Connectors, Inc.
      e. Spiral Manufacturing Co., Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Factory Fabricated Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 16 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Factory Fabricated Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Transverse Joints in Ducts Larger Than 16 Inches in Diameter: Flanged.
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Inner Duct: Minimum 0.028-inch solid or perforated sheet steel as indicated on drawings or in schedule below.

E. Interstitial Insulation: Two-inch thick fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Cover insulation with polyester film complying with UL 181, Class 1 in ducts with perforated inner liners.

2.5 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.6 DUCT LINER

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA Inc.
      b. Armacell LLC.
      c. Rubatex International, LLC
      d. Solacoustic
   2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
      a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   4. Factory coated with EPA approved microbial coating.

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick aluminum or stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
   7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
      b. Intervals of lined duct preceding unlined duct.
      c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
   9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches.
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
   10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.

6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
   3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
   4. Unconditioned Space, Exhaust Ducts: Seal Class B.
   5. Unconditioned Space, Return-Air Ducts: Seal Class B.
   6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
   7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
   8. Conditioned Space, Exhaust Ducts: Seal Class A.
   9. Conditioned Space, Return-Air Ducts: Seal Class B.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
      b. Supply Ducts with a Pressure Class of 4-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
      c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
      d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
      e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.
   7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   6. Provide drainage and cleanup for wash-down procedures.
   7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   1. Laboratory exhaust ducts.

B. Supply Ducts:
   1. Ducts downstream of variable air volume terminal units:
      a. Pressure Class: Positive 2-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 12 (non laboratory ducts) and 3 (laboratory ducts).
      d. SMACNA Leakage Class for Round and Flat Oval: 12 (non laboratory ducts) and 3 (laboratory ducts).
   2. Ducts upstream of Variable-Air Volume terminals Connected to Air-Handling Unit:
      a. Two inch double-wall from air handling unit to air terminal units including run-outs with perforated inner liner for first 50 feet from unit. Run-outs to air terminal units shall be one-inch double wall.
      b. Pressure Class: Positive 6-inch wg.
      c. Minimum SMACNA Seal Class: A.
      d. SMACNA Leakage Class for Rectangular: 3.
      e. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:
   1. Ducts Connected to Air-Handling Units:
      a. One-inch double-wall with perforated inner liner for first 50 feet from unit.
      b. Pressure Class: Negative 3-inch wg.
      c. Minimum SMACNA Seal Class: B.
      d. SMACNA Leakage Class for Rectangular: 12.
      e. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2 Air):
      a. Pressure Class: Negative, 3-inch wg.
      b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
   2. Ducts Connected to Air-Handling Units:
      a. Pressure Class: Positive or negative 4-inch wg.
      b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
      c. SMACNA Leakage Class for Rectangular: 6.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
   3. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:
      a. Type 316, stainless-steel sheet.
         1) Exposed to View: No. 3 finish.
         2) Concealed: No. 2B finish.
      b. Pressure Class: Positive or negative 4-inch wg.
      c. Minimum SMACNA Seal Class: A.
      d. SMACNA Leakage Class: 3.

4. Ducts Connected to Equipment Not Listed Above:
    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Air-Handling Units:
    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Equipment Not Listed Above:
    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 12.

F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts:
    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.
3. Aluminum Ducts: Aluminum.

G. Liner:
1. Supply Air Ducts: Flexible elastomeric, 1 inch thick.
2. Return Air Ducts: Fibrous glass, Type I or Flexible elastomeric, 1 inch thick.
3. Exhaust Air Ducts: Flexible elastomeric, 1 inch thick.
4. Transfer Ducts: Fibrous glass, Type I or Flexible elastomeric, 1 inch thick.

H. Double-Wall Duct Interstitial Insulation:
1. Supply Air Ducts: 1 or 2 inch thick as specified.

I. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
    a. Velocity 1000 fpm or Lower:
        1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
        2) Mitered Type RE 4 without vanes.
    b. Velocity 1000 to 1500 fpm:
        1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
    c. Velocity 1500 fpm or Higher:
        1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
    a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Radius-to Diameter Ratio: 1.5.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

J. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Manual volume dampers.
   2. Control dampers.
   3. Fire dampers.
   4. Smoke dampers.
   5. Combination fire and smoke dampers.
   6. Corridor dampers.
   7. Flange connectors.
   8. Duct silencers.
   9. Turning vanes.
   10. Remote damper operators.
   11. Duct-mounted access doors.
   12. Flexible connectors.
   13. Flexible ducts.
   14. Duct accessory hardware.

B. Related Requirements:
   1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
   2. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. LEED Submittals:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
   a. Special fittings.
   b. Manual volume damper installations.
   c. Control-damper installations.
   d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
   e. Duct security bars.
   f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.

2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 3-inch wg.

E. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.

F. Blades: Multiple single-piece blades, off-center pivoted, maximum 6-inch width, 0.050-inch- thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:
1. Material: Stainless steel.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Synthetic pivot bushings.

M. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
   a. Sleeve Thickness: 20 gage minimum.
   b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Bird.
9. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Flexmaster U.S.A., Inc.
   d. McGill AirFlow LLC.
   e. Nailor Industries Inc.
   f. Ruskin Company.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Stainless steel.
7. Bearings:
   a. Molded synthetic Stainless-steel sleeve.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. McGill AirFlow LLC.
   d. Nailor Industries Inc.
   e. Pottorff.
   f. Ruskin Company.
   g. Vent Products Company, Inc.
2. Comply with AMCA 500-D testing for damper rating.

3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
   a. Hat shaped.
   b. 0.094-inch- thick, galvanized sheet steel.
   c. Mitered and welded corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, roll-formed steel, 0.064 inch thick.
7. Blade Axles: Stainless steel.
8. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

2.5 CONTROL DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. McGill AirFlow LLC.
6. Metal Form Manufacturing, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. Pottorff.
10. Ruskin Company.
11. Vent Products Company, Inc.
12. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
1. Hat shaped.
2. 0.094-inch- thick, galvanized sheet steel.
3. Mitered and welded corners.

D. Blades:
1. Multiple blade with maximum blade width of 6 inches.
2. Opposed-blade design.
3. Aluminum.

4. 0.0747-inch- thick dual skin.
5. Blade Edging: PVC.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:
1. Oil-impregnated stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, product by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Nailor Industries Inc.
4. Pottorff.
5. Prefco; Perfect Air Control, Inc.
6. Ruskin Company.
7. Vent Products Company, Inc.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 6-inch wg static pressure class and minimum 2500-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory-installed, galvanized sheet steel.
1. Minimum Thickness: 0.138 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.7 SMOKE DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, product by one of the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   3. Greenheck Fan Corporation.
   4. Nailor Industries Inc.
   5. Pottorff.
   6. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

E. Blades: Roll-formed, horizontal, overlapping, 0.063-inch- thick, galvanized sheet steel.

F. Leakage: Class II.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.05-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: 24 volt, two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
   5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
   7. Electrical Connection: 24 Volt, single phase, 60 Hz.

K. Accessories:
   1. Auxiliary switches for signaling and position indication.
   2. Test and reset switches, damper or remote mounted.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, product by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 6-inch wg static pressure class and minimum 2500-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

G. Smoke Detector: Integral, factory wired for single-point connection.

H. Blades: Roll-formed, horizontal, overlapping, 0.034-inch- thick, galvanized sheet steel.

I. Leakage: Class II.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.05-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

L. Damper Motors: 24 volt, two-position action.

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Section ".
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 24 V, single phase, 60 Hz.

N. Accessories:
1. Auxiliary switches for signaling and position indication.
2. Test and reset switches, damper or remote mounted.

2.9 FLANGE CONNECTORS

A. Basis-of-Design Product: Subject to compliance with requirements, product by one of the following:
   1. Ductmate Industries, Inc.
   2. Nexus PDQ; Division of Shilco Holdings Inc.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.10 DUCT SILENCERS

A. Basis-of-Design Product: Subject to compliance with requirements, product by one of the following:
   1. Rink.
   2. Industrial Noise Control, Inc.
   3. McGill AirFlow LLC.
   4. Ruskin Company.
   5. Vibro-Acoustics.
   6. Nailor

B. General Requirements:
   1. Factory fabricated.
   2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
   3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Shape:
   1. Rectangular straight with splitters or baffles.
   2. Rectangular elbow with splitters or baffles.
   3. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.040 inch thick.

E. Inner Casing and Baffles: ASTM A 653/A 653M, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch- diameter perforations.

F. Special Construction:
   1. High transmission loss to achieve STC 45.

G. Connection Sizes: Match connecting ductwork unless otherwise indicated.

H. Principal Sound-Absorbing Mechanism:
   1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
   2. Film-lined type with fill material.

a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

3. Lining: Tedlar.

I. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. Joints: Continuously welded or flanged connections.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

J. Accessories:
1. Factory-installed end caps to prevent contamination during shipping.
2. Removable splitters.
3. Airflow measuring devices.

K. Source Quality Control: Test according to ASTM E 477.
1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

L. Capacities and Characteristics:
1. Configuration: Straight and 90-degree elbow as shown on plans.

2.11 TURNING VANES

A. Basis-of-Design Product: Subject to compliance with requirements, product by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single or Double wall.

E. Vane Construction: Single wall for ducts up to 24 inches wide and double wall for larger dimensions.

2.12 REMOTE DAMPER OPERATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. Pottorff.
   2. Ventfabrics, Inc.
   3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Copper.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed.

F. Wall-Box Cover-Plate Material: Steel.

2.13 DUCT-MOUNTED ACCESS DOORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Ductmate Industries, Inc.
   3. Elgen Manufacturing.
   4. Flexmaster U.S.A., Inc.
   5. Greenheck Fan Corporation.
   6. McGill AirFlow LLC.
   7. Nailor Industries Inc.
   8. Pottorff.
   9. Ventfabrics, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches with outside.
      d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
   1. Door and Frame Material: Galvanized sheet steel.

2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.14 DUCT ACCESS PANEL ASSEMBLIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.15 FLEXIBLE CONNECTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

2.16 FLEXIBLE DUCTS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Noninsulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 210 deg F.

C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 175 deg F.
   4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

D. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action and adhesive in sizes 3 through 18 inches, to suit duct size.

2.17 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot spacing.
   8. Upstream from turning vanes.
   9. Upstream or downstream from duct silencers.
   10. Control devices requiring inspection.
   11. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts with maximum 36-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with clamps.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

N:\N0912.00\DOC\SPEC\2012_03-16_BID\233300 FL - AIR DUCT ACCESSORIES.DOC

SECTION 233413 - AXIAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Mixed-flow fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on [**actual Project site elevations above**] sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For axial fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final locations, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MIXED-FLOW FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Loren Cook Company.
   2. Greenheck.
   3. New Philadelphia Fan Co.

C. Description: In-line, direct-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

D. General:
1. Base fan performance at standard conditions (density 0.075 Lb/ft^3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
3. Each fan shall be direct drive in AMCA arrangement 4 according to drawings.
4. Fans are to be equipped with lifting lugs.
5. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be industrial gray. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

E. Fan Housing and Outlet.
1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Tubular fan housing shall be completely welded and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be gray. No uncoated metal fan parts will be allowed.
3. Housing shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
4. All mixed flow housings shall include welded steel vanes to straighten airflow prior to exiting the fan discharge.
5. Units shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90 degree increments. Units shall allow for field rotation of motor positions. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.
6. An access door shall be supplied for impeller inspection and service.

F. Fan Impeller.
1. Fan impeller shall be mixed flow design. The impeller shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
2. Fan impeller shall be manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be industrial gray
3. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

G. Fan Motors and Drive.
1. Motors shall meet or exceed EPACT (Energy Policy ACT) efficiencies. Motors to be NEMA T-frame, 870, 1170 or 1770 in 60 Hz (720, 950, 720 in 50 Hz), Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor.

H. Accessories:
1. Companion Flanges: For inlet and outlet duct connections..

2.2 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install axial fans level and plumb.

B. Support floor-mounting units using spring isolators and inertia base having a static deflection of 2 inch. Vibration- control devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."
   1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

F. Install units with clearances for service and maintenance.

G. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

END OF SECTION 233413

N:\N0912.00\DOC\SPEC\2012_03-16_BID\233413 - AXIAL HVAC FANS.DOC

SECTION 233416- CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: For each product.
   1. Airfoil centrifugal fans.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Include rated capacities, furnished specialties, and accessories for each fan.
   2. Certified fan performance curves with system operating conditions indicated.
   3. Certified fan sound-power ratings.
   4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   5. Material thickness and finishes, including color charts.
   6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:
1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

B. Unusual Service Conditions:
1. Ambient Temperature: 70°F.
2. Altitude: 2000 feet above sea level.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Capacities and Characteristics: See plans.

2.2 AIRFOIL CENTRIFUGAL FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Acme Engineering & Mfg. Corp.
2. Chicago Blower Corporation.
3. Greenheck.
4. Penn Ventilation.
5. Loren Cook Company.
6. New York Blower Company (The).
7. Twin City Blower.

B. Description:
1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:
1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

D. Airfoil Wheels:
1. Single-width-single-inlet construction with curved inlet flange.
2. Heavy backplate.

3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Prelubricated and Sealed Shaft Bearings:
1. Self-aligning, pillow-block-type bearings.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

G. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

B. Premium efficiency, class F insulation, designed for inverter duty.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting: Install centrifugal fans on cast-in-place concrete equipment base(s) using elastomeric pads and restrained spring isolators. Comply with requirements for equipment bases specified in Section 033000 "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Minimum Deflection: 1 inch.
   2. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
   3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Install anchor bolts to elevations required for proper attachment to supported equipment.
   7. Install on 4-inch- high concrete base.

E. Install units with clearances for service and maintenance.

F. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:
1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416

N:\N0912.00\DOC\SPEC\2012_03-16_BID\233416 FL - CENTRIFUGAL HVAC FANS.DOC

SECTION 233423 – HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Centrifugal roof ventilators.
   2. Mixed flow in-line centrifugal fans.
   3. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Basis of Design Product: Subject to compliance with requirements, provide Greenheck, or a comparable product by one of the following:
   1. Loren Cook Company.
   2. New York Blower Company (The).
   3. Penn Ventilation.

B. Description: Direct- driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
   2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Direct-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum wire.
3. Gravity Dampers: Counter balanced, parallel-blade, backdraft dampers mounted in curb base, factory set to close when fan stops.
4. Variable speed controller: Solid state control to reduce speed from 100 to less than 50 percent.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Built-in cant and mounting flange.
2. Overall Height: 12 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.

H. Capacities and Characteristics: As scheduled on DWG. M702.

2.2 MIXED FLOW IN-LINE CENTRIFUGAL FANS

A. Basis of Design Product: Subject to compliance with requirements, provide products by one of the following:
1. Loren Cook Company.
2. New York Blower Company (The).
3. Penn Ventilation.

B. Description: In-line, direct-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. General:
1. Base fan performance at standard conditions (density 0.075 Lb/ft^3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
3. Each fan shall be direct drive in AMCA arrangement 4 according to drawings.
4. Fans are to be equipped with lifting lugs.
5. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be industrial gray. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

D. Fan Housing and Outlet.
1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Tubular fan housing shall be completely welded and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be gray. No uncoated metal fan parts will be allowed.

3. Housing shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
4. All mixed flow housings shall include welded steel vanes to straighten airflow prior to exiting the fan discharge.
5. Units shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90 degree increments. Units size 30 and larger shall allow for field rotation of motor positions. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.
6. An access door shall be supplied for impeller inspection and service.

E. Fan Impeller.
1. Fan impeller shall be mixed flow design. The impeller shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
2. Fan impeller shall be manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be industrial gray
3. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

F. Fan Motors and Drive.
1. Motors shall meet or exceed EPACT (Energy Policy ACT) efficiencies. Motors to be NEMA T-frame, 870, 1170 or 1770 in 60 Hz (720, 950, 720 in 50 Hz), Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor.

G. Accessories:
1. Companion Flanges: For inlet and outlet duct connections.

2.3 PROPELLER FANS

A. Basis of Design Product: Subject to compliance with requirements, provide Greenheck or camparable product by one of the following:
1. Loren Cook Company.
2. New York Blower Company (The).
3. Penn Ventilation.

B. Description: Direct-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

C. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Direct-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment made after installation.
1. Service Factor Based on Fan Motor Size: 1.4.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

F. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall housing flush with exterior and with OSHA guard.
4. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
5. Variable speed controller: Solid state control to reduce speed from 100 to less than 50 percent.
6. Aluminum 45°degree weather hood with bird screen.

2.4 MOTORS

A. Comply with requirements in Division 15 Section "Motors."

B. Enclosure Type: Totally enclosed, fan cooled.

2.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Suspend or support units using isolators. Vibration- control devices are specified in Division 15 Section "Mechanical Vibration Control."

C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 Section "Roof Accessories" for installation of roof curbs.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system.
   5. Adjust damper linkages for proper damper operation.
   6. Verify lubrication for bearings and other moving parts.
   7. Verify that manual and automatic volume control smoke dampers in connected ductwork systems are in fully open position.
   8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   9. Shut unit down and reconnect automatic temperature-control operators.
   10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

C. Replace fan as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION 233423

N:\N0912.00\DOC\SPEC\2012_03-16_BID\233423 - HVAC POWER VENTILATORS.DOC

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Shutoff single-duct air terminal units.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 1.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

A. Basis of Design Product: Subject to compliance with requirements, provide Titus or a comparable product by one of the following:
   1. Nailor Industries of Texas Inc.
   2. Trane Co. (The); Worldwide Applied Systems Group.

B. Configuration: Volume-supply or exhaust damper assembly inside unit casing with control components located inside a protective metal shroud. Supply VAV terminals shall be specifically designed for supply applications, and exhaust air terminals for exhaust applications.

C. Casing:
   1. Casing Material:
      a. 0.034-inch steel, for all VAV supply and exhaust terminals except exhaust terminals serving Anatomy and Physiology laboratory #202.
      b. Exhaust terminals serving laboratory #202 shall have 316-stainless steel casing.
   2. Casing Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
   3. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   4. Air Outlet: S-slip and drive connections.
   5. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.
   1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.
   2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 6-inch wg inlet static pressure.
   2. Damper Position: Refer to control sequences.

F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.

G. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor shall be compatible with temperature controls specified in other Division 15 Sections and shall have the following features:
   1. Damper Actuator: 24 V, powered closed, spring return open.
   2. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
   3. Thermostat: Wall-mounting electronic type with the following features:
      a. Proportional, plus integral control of room temperature.
      b. Time-proportional reheat-coil control.
      c. Temperature set-point display in Fahrenheit and Celsius.

H. DDC Controls: Single-package unitary controller and actuator specified in Division 15 Section "HVAC Instrumentation and Controls."

I. Control Sequence:
   1. As indicated on drawings.

2.2 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot-Water Piping: In addition to requirements in Division 15 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer and union; and to return with balancing valve, control valve and union.

D. Connect ducts to air terminal units according to Division 15 Section "Metal Ducts."

E. Connect wiring according to Division 16 Section "Conductors and Cables."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions and do the following:
      a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
      b. Verify that controls and control enclosure are accessible.
      c. Verify that control connections are complete.
      d. Verify that nameplate and identification tag are visible.
      e. Verify that controls respond to inputs as specified.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 1.

END OF SECTION 233600

N:\N0912.00\DOC\SPEC\2012_03-16_BID\233600 - AIR TERMINAL UNITS.DOC

SECTION 233601 - AIR VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SYSTEM DESCRIPTION

A. A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. The exhaust flow rate of a laboratory fume hood shall be precisely controlled to maintain a constant average face velocity into the fume hood at either a standard in-use or standby level based on an operator being present in front of the fume hood. The laboratory control system shall vary the amount of makeup/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces (positive or negative). The laboratory airflow control system shall be capable of operating as a stand-alone system, or as a system integrated with the Building Management System (BMS).

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For air valves to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.4 PREVENTIVE MAINTENANCE

A. The laboratory airflow control system supplier shall provide, at no additional cost to the owner during and after the warranty period, five years of required preventive maintenance on all airflow sensors (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.), and flow transducers provided under this section. Airflow sensors shall be removed, inspected, and cleaned annually during the five year period to prevent inaccuracies due to long term buildup from corrosion, lab tissues, wet or sticky particles, or other materials that foul the sensor. If impractical to remove the airflow sensors, the laboratory airflow control system supplier shall include in the proposal the cost of supplying and installing duct access

doors, one for each sensor. The transducer shall be checked and recalibrated annually to insure long-term accuracy. Note that auto-zero recalibration of transducers is not acceptable as a substitute for annual recalibration.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air valves and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air valves according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.6 COORDINATION

A. Coordinate layout and installation of air valves and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Warranty shall commence upon the date of substantial completion and extend for a period of thirty-six months whereupon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements:
      a. The plans and specifications for the laboratory airflow control system are based on systems and equipment manufactured by Phoenix Controls Corporation.
      b. In strict accordance with this specification, alternative laboratory airflow control systems and equipment shall only be considered for approval provided that the equipment be equal in every respect to the operational characteristics, capacities, and intent of control sequences specified herein. Approval to bid does not relieve the laboratory airflow control system supplier from complying with the minimum requirements or intent of this specification.
      c. The engineer and owner shall be the sole judges of quality and equivalence of equipment, materials, methods, and life cycle cost.
      d. Any alternate laboratory airflow control system supplier shall submit a detailed technical proposal for the owner’s evaluation. The proposal shall describe the manner of compliance with this minimum performance specification, with

particular emphasis on the following areas: diversity and energy analysis; proposed equipment; experience and performance verification. This proposal shall be separate from any other proposals.

e. Proposed Equipment
   1) The laboratory airflow control system supplier shall provide a detailed proposal describing all elements of the laboratory control system. A schematic laboratory layout shall be provided, showing relations of these elements and a description of how they interact.
   2) Technical specification data sheets shall be provided for all proposed system components and devices.
   3) All proposed airflow control devices shall include discharge, exhaust, and radiated sound power level performance obtained from testing in accordance with ARI Standard 880.

f. Experience
   1) The laboratory airflow control system supplier shall provide a list of at least three similar laboratory airflow control systems installed in the state or province as part of this proposal.
   2) The laboratory airflow control system supplier shall provide the names, addresses, and the telephone numbers of the consulting engineer and the owner's representative for each of these installations. It is understood that these individuals may be contacted regarding timely delivery, the quality of installation, the operation and performance of the equipment and the service requirements for each installation. Unsatisfactory performance or inability to provide references shall be grounds for rejection.

g. Performance Verification
   1) The laboratory airflow control system supplier shall demonstrate a typical laboratory space that includes multiple fume hoods, a general exhaust, and a supply airflow control device for the purpose of verifying the laboratory airflow control system's ability to meet the performance requirements indicated in this specification. All travel and lodging costs to witness the performance verification shall be the responsibility of the laboratory airflow control system supplier.

2.2 AIRFLOW CONTROL SYSTEM DESCRIPTION

A. Each individual laboratory shall have a dedicated laboratory airflow control system. Each dedicated laboratory airflow control system shall support a minimum of twenty (20) network controlled airflow devices.

B. The laboratory airflow control system shall employ individual average face velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood's exhaust airflow to maintain a constant face velocity over a minimum range of 20% to 100% of sash travel. The corresponding minimum hood exhaust flow turndown ratio shall be 5 to 1.

C. The hood exhaust airflow control device shall respond to the fume hood sash opening by achieving 90% of its commanded value within one second of the sash reaching 90% of its final position (with no more than 5% overshoot/ undershoot) of required airflow. Rate of sash movement shall be between 1.0 to 1.5 feet per second.

D. The hood exhaust airflow control device shall be automatically switched between in-use and standby levels based on operator presence immediately in front of the hood. A presence and

motion sensor shall activate the switching. The airflow control device shall achieve the required in-use commanded value in less than one second from moment of detection with no more than a 5% overshoot or undershoot.

E. The laboratory airflow control system shall maintain specific airflow (±5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change airflow change or quantity of airflow control devices on the manifold (within 0.6" to 3.0" wc),

F. The laboratory airflow control system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.

G. The laboratory airflow control system shall maintain specific airflow (±5% of signal) with a minimum 16 to 1 turndown to insure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.

2.3 2AIRFLOW CONTROL SOUND SPECIFICATIONS

A. Unless otherwise specified, the airflow control device shall not exceed the sound power levels in Table 1, Table 2 and Table 3.

B. If the airflow control device cannot meet the sound power level specification, a properly sized silencer or sound attenuator must be used. All silencers must be of a packless design (constructed of at least 18 gauge 316L stainless steel when used with fume hood exhaust) with a maximum pressure drop at the device's maximum rated flow rate not to exceed 0.20 inches of water.

C. All proposed airflow control devices shall include discharge, exhaust and radiated sound power level performance.

Table 1. Exhaust Airflow Control Device Sound Power Level

Exhaust Sound Power Level in dB (re: 10^{-12} watts)

Octave Band Number	2	3	4	5	6	7
Center Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
			1000-50 cfm Device			
800 cfm @ 0.6" wc	63	55	52	54	50	49
200 cfm @ 0.6" wc	46	42	38	37	32	25
800 cfm @ 3.0" wc	73	70	64	66	65	60
200 cfm @ 3.0" wc	51	52	51	50	52	51
			1500-100 cfm Device			
1200 cfm @ 0.6" wc	65	58	53	56	52	52
400 cfm @ 0.6" wc	50	45	38	39	37	31
1200 cfm @ 3.0" wc	72	70	62	65	64	60
400 cfm @ 3.0" wc	55	57	55	53	56	55

			3000-200 cfm Device			
2400 cfm @ 0.6" wc	63	56	55	58	54	55
800 cfm @ 0.6" wc	51	45	41	42	39	34
2400 cfm @ 3.0" wc	75	71	65	68	67	63
800 cfm @ 3.0" wc	58	58	56	56	59	58

Table 2. Supply Airflow Control Device Sound Power Level (Discharge)

Discharge Sound Power Level in dB (re: 10^{-2}

OctaveBandNumber	2	3	4	5	6	7
Center Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
			1000-50 cfm Device			
800 cfm @ 0.6" wc	62	57	54	58	54	51
200 cfm @ 0.6" wc	45	46	42	44	40	34
800 cfm @ 3.0" wc	72	71	67	75	72	68
200 cfm @ 3.0" wc	53	56	54	58	56	54
			1500-100 cfm Device			
1200 cfm @ 0.6" wc	63	59	55	60	54	53
400 cfm @ 0.6" wc	53	49	44	49	45	39
1200 cfm @ 3.0" wc	72	73	69	77	72	68
400 cfm @ 3.0" wc	58	63	61	63	60	57
			3000-200 cfm Device			
2400 cfm @ 0.6" wc	64	60	58	63	56	56
800 cfm @ 0.6" wc	52	48	47	52	46	41
2400 cfm @ 3.0" wc	75	75	72	78	73	70
800 cfm @ 3.0" wc	59	62	62	66	62	60

Table 3. Supply Airflow Control Device Sound Power Level (Radiated)

Radiated Sound Power Level in dB (re: 10^{-12}

OctaveBandNumber	2	3	4	5	6	7
Center Frequency in Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
			1000-50 cfm Device			
800 cfm @ 0.6" wc	44	41	45	41	36	34
200 cfm @ 0.6" wc	33	28	31	29	26	20
800 cfm @ 3.0" wc	53	53	56	57	55	53
200 cfm @ 3.0" wc	41	38	41	39	39	37
			1500-100 cfm Device			
1200 cfm @ 0.6" wc	47	53	40	42	38	36
400 cfm @ 0.6" wc	35	39	31	34	33	26
1200 cfm @ 3.0" wc	52	60	54	60	59	53
400 cfm @ 3.0" wc	42	44	43	46	46	42
			3000-200 cfm Device			
2400 cfm @ 0.6" wc	58	56	45	47	43	42
800 cfm @ 0.6" wc	45	43	36	39	37	29
2400 cfm @ 3.0" wc	69	68	60	65	63	57
800 cfm @ 3.0" wc	54	53	48	51	50	48

2.4 USAGE BASED CONTROL EQUIPMENT

A. For variable air volume (VAV) systems, a sash sensor shall be provided to measure the height of each vertically moving fume hood sash. A sash sensor shall also be provided for horizontal overlapping sashes. Control systems employing sidewall-mounted velocity sensors shall be unacceptable.

B. A presence and motion sensor shall be provided to determine an operator's presence in front of a hood by detecting the presence and/or motion of an operator, and to command the laboratory airflow control system from an in-use operating face velocity (e.g., 100 fpm) to a standby face velocity (e.g., 60 fpm) and vice versa.
   1. The sensor shall define a detection zone that extends approximately 20" (50 cm) from the front of the fume hood. If the sensor does not detect presence and/or motion in its detection zone within five seconds, it shall command the system to the user-adjustable standby face velocity. When the sensor detects the presence and/or motion of an operator within the detection zone, it shall command the system to the in-use face velocity within 1.0 second.
   2. The sensor shall have a control circuit that adapts to its specific surroundings and automatically adjusts for inanimate objects placed within its detection zone. It shall map the area into memory and, after a period of five minutes, nullify the image of the inanimate object and return to a standby mode. Operators shall enter and leave the zone with the unit automatically adjusting between in-use and standby modes. If the inanimate object is moved or taken out of the zone, the unit shall automatically re-map the area.
   3. Wide area motion detectors (on the hood or room level) shall be unacceptable.

C. The airflow at the fume hood shall vary in a linear manner between two adjustable minimum and maximum flow set points to maintain a constant face velocity throughout this range. A minimum volume flow shall be set to assure flow through the fume hood even with the sash totally closed.

D. A fume hood monitor shall be provided to receive the sash sensor output and presence and/or motion signal. This same monitor shall generate an exhaust airflow control signal for the appropriate airflow control device in order to provide a constant average face velocity. Audible and separate visual alarms shall be provided for both flow alarm and emergency exhaust conditions.

2.5 AIRFLOW CONTROL DEVICE - GENERAL

A. The airflow control device shall be a venturi valve.

B. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifolded system.

C. The airflow control device shall maintain accuracy within ±5% of signal over an airflow turndown range of no less than 16 to 1.

D. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.

E. The airflow control device shall be constructed of one of the following three types:
   1. Class A - The airflow control device for non-corrosive airstreams such as supply and general exhaust shall be constructed of 16-gauge aluminum. The device's shaft and shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of aluminum. The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of a Teflon, or polyester, or PPS (polyphenylene sulfide) composite.
   2. Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.
   3. Class B - The airflow control device for corrosive airstreams such as fume hoods and bio-safety cabinets shall have a baked-on corrosion resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring-grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of a Teflon or PPS (polyphenylene sulfide) composite.
   4. Class C - The airflow control device for highly corrosive airstreams shall be constructed as defined in Paragraph D.2 and, in addition, shall have no exposed aluminum or stainless steel components. Shaft support brackets, pivot arm, internal mounting link, and pressure independent springs shall have a baked on corrosion resistant phenolic coating in addition to the materials defined in paragraph D.2. The internal nuts, bolts, and rivets shall be titanium or phenolic coated stainless steel. Only devices clearly defined as “High Corrosion Resistant” on project drawings will require this construction.

F. For two-position or VAV operation, low-voltage, fast acting, electric actuator shall be factory mounted to the valve. Loss of control power shall cause normally open valves to fail to maximum position, and normally closed valves to fail to minimum position. Electric actuators that fail in last position are not

acceptable when used in fume hood and make-up air control applications. Constant volume valves do not require actuators.

G. The controller for the airflow control devices shall be microprocessor based and operate using a peer-to-peer control architecture. The room-level airflow control devices shall function as a stand-alone network.

H. The room-level control network shall utilize a LonTalk communications protocol.

I. There shall be no reliance on external or building-level control devices to perform room-level control functions. Each laboratory control system shall have the capability of performing; Fume hood control, Pressurization control, Temperature control, Humidity control, and implement Occupancy and Emergency mode control schemes.

J. The laboratory airflow control systems shall have the option of digital integration with the BMS.

K. Certification
   1. Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of at least ±1% of signal over the entire range of measurement. Electronic airflow control devices shall be further calibrated and their accuracy verified to ±5% of signal at a minimum of forty-eight different airflows across the full operating range of the device.
   2. All airflow control devices shall be individually marked with device specific, factory calibration data. At a minimum, it should include: tag number, serial number, model number, eight point characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation.

L. Airflow control devices that are not venturi valves, and airflow measuring devices (e.g., pitot tube, flow cross, air bar, orifice ring, vortex shedder, etc.) shall only be acceptable provided they meet all the performance and construction characteristics as stated throughout this specification and:
   1. The airflow control device employs transducers manufactured by Rosemount, Bailey, Bristol, or Foxboro. Accuracy shall be no less than ±0.15% of span (to equal ±5% of signal with a 15 to 1 turndown) over the appropriate full scale range including the combined effects of nonlinearity, hysteresis, repeatability, drift over a one year period, and temperature effect. 316L stainless steel materials shall be provided for all exhaust applications. The use of 304 stainless steel materials shall be provided for all make-up air applications.
   2. Airflow sensors shall be of a multi-point averaging type, 304 stainless steel for all supply and general exhaust applications, 316L stainless steel for all fume hood, canopy, snorkel, and bio-safety cabinet applications. Single point sensors are not acceptable.
   3. Suppliers of airflow control devices or airflow measuring devices requiring minimum duct diameters shall provide revised duct layouts showing the required straight duct runs upstream and downstream of these devices. Coordination drawings reflecting these changes shall be submitted by the supplier of the laboratory airflow control system. In addition, suppliers shall include static pressure loss calculations as part of their submittals. All costs to modify the ductwork, increase fan sizes and horsepower, and all associated electrical changes shall be borne by the laboratory airflow control supplier.

2.6 EXHAUST AND SUPPLY AIRFLOW DEVICE CONTROLLER

A. The airflow control device shall be a microprocessor-based design and, shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.

B. The airflow control device shall store its control algorithms in non-volatile, re-writable memory. The device shall be able to stand-alone or to be networked with other room level digital airflow control devices using an industry standard protocol.

C. Room-level control functions shall be embedded in and carried out by the airflow device controller using a distributed control architecture. Critical control functions shall be implemented locally, no room-level controller shall be required.

D. The airflow control device shall use industry standard 24 Vac power.

E. The airflow control device shall have provisions to connect a notebook PC commissioning tool and every node on the network shall be accessible from any point in the system.

F. The airflow control device shall have built-integral Input/Output connections address fume hood control, temperature control, humidity control occupancy control, emergency control and non-network sensors switches and control devices. At a minimum the airflow controller shall have:
   1. Three (3) Universal Inputs, capable of accepting 0 to 10Vdc, 4 to 20mA, 0 to 65k ohms, or Type 2 or Type 3 10k ohm @ 25 degree C thermistor temperature sensors.
   2. One (1) Digital Input capable of accepting a dry contact or logic level signal input.
   3. Two (2) Analog Outputs capable of developing either a 0 to 10Vdc, or 4 to 20mA linear control signal.
   4. One (1) Form C (SPDT) relay output capable of driving up to 1A @ 24Vac/Vdc.

G. The airflow control device shall meet FCC Part 15 Subpart J Class A, and be UL916 listed.

2.7 TWO-POSITION EXHAUST AIRFLOW CONTROL DEVICE

A. The airflow control device shall maintain a factory calibrated fixed maximum and minimum flow setpoint based on a switched 0 to 10 volt signal. Two-position devices requiring feedback shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow. All Two-Position devices shall either be networks, or hard-wired into the room-level network so as to be considered under pressurization control.

2.8 LABORATORY OFFICE AIRFLOW CONTROL DEVICE

A. The airflow control device shall maintain a temperature set point by controlling the airflow and the reheat valve (if required) in response to a room temperature sensor. An additional output shall be provided for supplementary cooling or heating of the office space. If the office airflow supply device is not required for make-up airflow control for fume hoods, then the 1-second speed of response, and fail-safe conditions required of the laboratory airflow control system shall not apply.

2.9 CONSTANT VOLUME AIRFLOW CONTROL DEVICE

A. The airflow control device shall maintain a constant airflow setpoint. It shall be factory calibrated and set for the desired airflow. It shall also be capable of field adjustment for future changes in desired airflow.

B. Laboratory airflow control systems suppliers not employing constant volume venturi airflow control valves shall provide pneumatic tubing or electrical wiring as required for their devices.

2.10 CLOSED LOOP VARIABLE FREQUENCY DRIVE

A. The drive shall be a high-performance pulse width modulated design, which generates a sine-coded, adjustable voltage/frequency, three phase output for complete speed control of any conventional squirrel cage induction motor.

B. The device shall not induce any voltage line notching distortion back to the utility line. The device shall maintain a displacement power factor of not less than 0.95 throughout its speed range. Synchronism between drive frequency and motor speed shall be maintained under all conditions.

C. The drive shall automatically restart a coasting motor after a power outage of any duration without tripping or shutting down. The drive shall apply rated power to accelerate the motor to the commanded speed within 0.5 second of the reapplication of drive power or the removal of a motor fault condition.

D. The drive shall accelerate the motor rapidly, limited only by the motor's rated torque and load.

E. An alarm circuit indicating low face velocity shall be included to electronically sense a loss of airflow via a drop in actual (not calculated) motor power or a difference between the actual and commanded motor speed. The alarm shall be enunciated through audible and visual means at the fume hood monitor.

2.11 CONTROL FUNCTIONS

A. The airflow control devices shall utilize a peer-to-peer, distributed control architecture to perform room-level control functions. Master/Slave control schemes shall not be acceptable. Control functions shall at a minimum include, pressurization, temperature, humidity control and respond to occupancy and emergency control commands.

B. Pressurization Control
1. The laboratory control system shall control supply and auxiliary exhaust airflow devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. This offset shall be field adjustable and represents the volume of air, which will enter (or exit) the room from the corridor or adjacent spaces.
2. The pressurization control algorithm shall sum the flow values of all Supply and Exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. The offset shall be adjustable.
3. The pressurization control algorithm shall consider both networked devices, as well as:
   a. Up to three (3) non-networked devices providing a linear analog flow signal.
   b. Any number of Constant Volume devices where the total of supply devices and the total of exhaust devices may be factored into the pressurization control algorithm.
4. Volumetric offset shall be the only acceptable means of controlling room pressurization. Systems that rely on differential pressure as a means of control shall provide documentation to demonstrate that space pressurization can be maintained if fume hood sashes are changed at the same time a door to the space is opened.
5. The pressurization control algorithm shall support the ability to regulate the distribution of total supply flow across multiple supply airflow control devices in order to optimize air distribution in the space.

C. Temperature Control
1. The laboratory control system shall regulate the space temperature through a combination of volumetric thermal override and control of reheat coils and/or auxiliary temperature control devices. The laboratory control system shall support up to four separate temperature zones for each pressurization zone. Each zone shall have provisions for monitoring up to five (5) temperature inputs and calculating a straight-line average to be used for control purposes. Separate

cooling and heating set points shall be writable from the BMS, with the option of a local offset adjustment.

2. Temperature control shall be implemented through the use of independent primary cooling and heating control functions, as well as an auxiliary temperature control function, which may be used for either supplemental cooling or heating. Cooling shall be provided as a function of thermal override of conditioned air with both supply and exhaust airflow devices responding simultaneously so as to maintain the desired offset. Heating shall be provided through modulating control of a properly sized reheat coil.
3. The laboratory control system shall also provide the built-in capability for being configured for Hot Deck/Cold Deck temperature control.
4. The auxiliary temperature control function shall offer the option of either heating or cooling mode and to operate as either a stand-alone temperature control loop, or staged to supplement the corresponding primary temperature control loop.

D. Humidity Control
1. The Laboratory control system shall have an embedded humidity control function, which allows the monitoring and control of the relative humidity level in the pressurized zone. Using peer-to-peer control, the airflow devices shall have the ability to monitor the relative humidity level of the space and, based on a BMS writable set point, develop a control signal to drive one or the other humidification or dehumidification control circuits.
2. The humidity control loop(s) shall share a common set point, with a configurable deadband adjustment to prevent the humidification and dehumidification control functions to operate at the same time.

E. Occupancy Control
1. The laboratory control system shall have the ability to change the minimum ventilation and/or temperature control set points, based on the occupied state, in order to reduce energy consumption when the space is not occupied. The occupancy state may be set by either the BMS, as a scheduled event, or through the use of a local occupancy sensor or switch. The laboratory control system shall support a local occupancy override button that allows a user to override the occupancy mode and set the space to occupied, for a predetermined interval. The override interval shall be configurable for 1 to 1,440 minutes. The local occupancy sensor/switch, or bypass button shall be given priority over a BMS command.

F. Emergency Mode Control
1. The laboratory control system shall provide a means of overriding temperature and pressurization control in response to a command indicating an emergency condition exists and airflow control devices are to be driven to a specific flow set point. The system shall support up to four (4) emergency control modes. The emergency control modes may be initiated either by a local contact input, or BMS command.
2. Once an Emergency mode is invoked, pressurization and temperature control are overridden for the period that the mode is active. Emergency modes shall have a priority scheme allowing a more critical mode to override a previously set condition.

G. Local Alarm Control
1. The laboratory control system shall provide the means of summing selective alarm activity at the room-level network and generating a local alarm signal. The local alarm signal may be directed to any available output, as well as to the BMS. The alarm mask may be configured differently for each room-level system.

H. Diversity Alarm
1. The laboratory control system shall have the ability of monitoring the airflow values for the pressurized space, and generating an alarm signal in the event the Total Supply flow exceeds a predetermined threshold. The Diversity Alarm is intended to allow the user to take diversity in the

design and generate an alarm condition in the event the diversity threshold is compromised. This function must be available in either an integrated or stand-alone system.

I. Fume Hood Control

1. Airflow devices intended to control the face velocity of a fume hood, shall have the ability to interface directly with the Fume Hood Monitoring device. The airflow control device shall:
    a. Accept command inputs to regulate the flow accordingly and make this command value available to the BMS.
    b. Accept a Sash Position signal and make this value available to the BMS.
    c. Accept a Usage Based Control signal to indicate user presence and make this signal available to the BMS.
    d. Provide a flow feedback signal to the Fume Hood Monitor, which may be used for calculating face velocity, or to confirm the airflow device has achieved the proper flow rate and make this value available to the BMS.
    e. Provide alarm signals to the Fume Hood Monitor in the event the airflow device is unable to achieve the proper flow rate, or there is a loss of static pressure indicating improper fan operation, or that there is a loss of power to the airflow control device, in order to provide a local alarm indication.
2. The fume hood airflow control device shall respond to changes in sash position and user presence within 1 second, in order to provide a constant 100 feet per minute face velocity when the fume hood is in use.

J. The laboratory control system shall be segregated into individual sub nets to isolate network communications to insure room-level control functions and BMS communications may be carried out reliably. Each laboratory space, or pressurization zone shall be it's own sub net. Commercially available routers shall be used to provide this isolation.

K. The laboratory airflow control system shall support at least 20-networked devices in each pressurized zone.

L. All points shall be available through the interface to the building management system (BMS) for trending, archiving, graphics, alarm notification, and status reports. Laboratory airflow control system performance (speed, stability, and accuracy) shall be unaffected by the quantity of points being monitored, processed, or controlled.

M. Refer to the BMS specification for the required input/output summary for the necessary points to be monitored and/or controlled. 3.10.

2.12 INTERFACE TO BUILDING MANAGEMENT SYSTEMS

A. The laboratory airflow control system network shall have the capability of digitally interfacing with the BMS. The required software interface drivers shall be developed and housed in a Gateway, a dedicated interface device furnished by the laboratory airflow control system supplier.

B. Any, or all room-level points shall be available to the BMS for monitoring or trending. The Gateway shall maintain a cache of all points to be monitored by the BMS. The room-level airflow control devices shall update this cache continually.

C. The building-level network shall be a high-speed LonTalk (1.25 mbps) communications protocol. The building-level network shall support up to one hundred (100) sub nets, or pressurization zones, or six thousand (6,000) data points.

D. A commercially available interface card shall be provided with the Accel-Way in order to connect to the building-level network.

E. A commercially available network interface card shall be provided with the Accel-Way to interface with the BMS.

2.13 SOURCE QUALITY CONTROL

A. Identification: Label each air valve with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The automatic temperature controls (ATC) contractor shall install the sash sensors, interface boxes, presence and motion sensor, and fume hood monitor on the fume hood under initial supervision of the laboratory airflow control system supplier. Reel-type sash sensors and their stainless steel cables shall be hidden from view. Bar-type sash sensors shall be affixed to the individual sash panels. Sash interface boxes with interface cards shall be mounted in an accessible location.

B. The ATC contractor shall install all Routers and Repeaters in an accessible location in or around the designated laboratory room.

C. The ATC shall install an appropriately sized and fused 24 Vac transformer suitable for NEC Class II wiring.

D. The ATC contractor shall install 20 psi clean, dry pneumatic supply air to all airflow control devices, where required.

E. All cable shall be furnished and installed by the ATC contractor. The ATC contractor shall terminate and connect all cables as required. The ATC shall utilize cables specifically recommended by the laboratory airflow controls supplier.

F. The mechanical contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.

G. The mechanical contractor shall provide and install all reheat coils and transitions.

H. The mechanical contractor shall provide and install insulation as required.

I. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

J. Install air valves level and plumb. Maintain sufficient clearance for normal service and maintenance

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air valves to allow service and maintenance.

C. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

D. Connect ducts to air valves according to Division 23 Section "Metal Ducts."

E. Connect wiring according to Division 16 Section "Conductors and Cables."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
1. After installing air valves and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. System start-up shall be provided by a factory-authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust, or return), system programming and integration to BMS (when applicable).

B. The balancing contractor shall be responsible for final verification and reporting of all airflows.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air valves. Refer to Division 1.

B. The laboratory airflow control system supplier shall furnish a minimum of eight hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures.

C. Operation and Maintenance manuals, including as-built wiring diagrams and component lists shall be provided for each training attendee.

END OF SECTION 233601

N:\N0912.00\DOC\SPEC\2012_03-16_BID\233601 - AIR VALVES.DOC

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Square ceiling diffusers.
   2. Perforated diffusers.
   3. Louver face diffusers.
   4. Linear slot diffusers.
   5. Adjustable bar registers and grilles.
   6. Fixed face registers and grilles.
   7. High capacity, low induction diffusers.

B. Related Sections:
   1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.

E. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Square Ceiling Diffusers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   a. Anemostat Products; a Mestek company.
   b. Carnes.
   c. Krueger.
   d. Nailor Industries Inc.
   e. Titus.
   f. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel.
4. Finish: Baked enamel, color selected by Architect.
5. Face Size: 24 by 24 inches or 12 by 12 inches.
6. Face Style: Three-cone.
7. Mounting: Surface or T-bar.
8. Pattern: Adjustable.
9. Dampers: Butterfly.
10. Accessories:
    a. Equalizing grid.
    b. Sectorizing baffles.

B. Perforated Diffuser:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   a. Anemostat Products; a Mestek company.
   b. Carnes.
   c. Krueger.
   d. Nailor Industries Inc.
   e. Titus.
   f. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel backpan and pattern controllers, with steel face.
4. Finish: Baked enamel, color selected by Architect.
5. Face Size: 12 by 12 inches or 24 by 24 inches.
6. Duct Inlet: Round.
7. Face Style: Flush.
8. Mounting: Surface or T-bar.
9. Pattern Controller: Fixed with curved blades at inlet.
10. Dampers: Radial opposed blade.
11. Accessories:
    a. Equalizing grid.

C. Louver Face Diffuser:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   a. Anemostat Products; a Mestek company.

b. Carnes.
c. Nailor Industries Inc.
d. Titus.
e. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel.
4. Finish: Baked enamel, color selected by Architect.
5. Face Size: As scheduled.
6. Mounting: Surface or T-bar.
7. Pattern: Four-way core style.
8. Dampers: Radial opposed blade.
9. Accessories:
   a. Adjustable pattern vanes.
   b. Sectorizing baffles.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   a. Anemostat Products; a Mestek company.
   b. Carnes.
   c. Krueger.
   d. Nailor Industries Inc.
   e. Titus.
   f. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material - Shell: Steel, insulated.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish - Face and Shell: Baked enamel, black.
6. Finish - Pattern Controller: Baked enamel, black.
7. Finish - Tees: Baked enamel, color selected by Architect.
8. Slot Width: As shown on schedule.
9. Number of Slots: As shown on schedule.
10. Length: As shown on schedule.
11. Accessories: T-bar clips on both sides.

2.3 REGISTERS AND GRILLES

A. Adjustable Bar Register:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   a. Anemostat Products; a Mestek company.
   b. Carnes.
   c. Krueger.
   d. Nailor Industries Inc.
   e. Titus.
   f. Tuttle & Bailey.
2. Material: Steel.
3. Finish: Baked enamel, color selected by Architect.
4. Face Blade Arrangement: Horizontal spaced as shown on schedule.
5. Core Construction: Integral.

6. Rear-Blade Arrangement: Vertical spaced, as shown on schedule.
7. Frame: 1 inch wide.
8. Mounting: Countersunk screw.
9. Damper Type: Adjustable opposed blade.
10. Accessories:

B. Adjustable Bar Grille:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   a. Anemostat Products; a Mestek company.
   b. Carnes.
   c. Krueger.
   d. Nailor Industries Inc.
   e. Titus.
   f. Tuttle & Bailey.
2. Material: Steel.
3. Finish: Baked enamel, color selected by Architect.
4. Face Blade Arrangement: Horizontal spaced, as shown on schedule.
5. Core Construction: Integral.
6. Rear-Blade Arrangement: As shown on schedule.
7. Frame: 1 inch wide.
8. Mounting Frame: Flanged..
9. Mounting: Countersunk screw.

C. Fixed Face Grille:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   a. Anemostat Products; a Mestek company.
   b. Carnes.
   c. Krueger.
   d. Nailor Industries Inc.
   e. Titus.
   f. Tuttle & Bailey.
2. Material: Steel.
3. Finish: Baked enamel, color selected by Architect.
4. Face Arrangement: As shown on schedule.
5. Core Construction: Integral.
6. Frame: 1 inch wide.
7. Mounting: Countersunk screw.
8. Damper Type: Adjustable opposed blade.

D. High-Capacity, Low Induction Supply Diffusers
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   a. Anemostat Products; a Mestek company.
   b. Nailor Industries Inc.
2. Ceiling flushed, perforated, radial pattern diffuser.
3. Steel distribution plenum with internal spreading means and round inlet collar.
4. Finish the diffuser in white enamel.
5. Lay-in frame.
6. Sizes and capacity as shown on schedule.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

N:\N0912.00\DOC\SPEC\2012_03-16_BID\233713_DIFFUSERS,REGISTERS AND GRILLES.DOC

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube and water-jacketed condensing boilers, trim, and accessories for generating hot water.
   1. Secure Maryland Department of Environment (MDE) air quality permit-to-construct for all fuel burning equipment where required (Comar 26.11.02)

1.3 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Warranty: Special warranty specified in this Section.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Fire-Tube Condensing Boilers:
      a. Leakage and Materials: 10 years from date of Substantial Completion.
      b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Non-prorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AERCO International.
   2. Viessmann Manufacturing Co. (US) Inc.

2.2 FIRE-TUBE CONDENSING BOILERS

A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Nonferrous, stainless steel combustion chamber.

C. Pressure Vessel: SA53 carbon steel with 0.25-inch thick wall and 0.25-inch thick upper heads and tube connections or high alloy stainless steel and titanium.

D. Burner: Natural gas, forced draft capable of 15:1 turn down ratio or full modulating without loss of efficiency and low NOx.

E. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
   1. Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

H. Exhaust and condensate collector: Stainless steel construction.

I. Casing:
1. Jacket: Sheet metal with interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Baked-enamel or powder-coated protective finish.
4. Insulation: Minimum 4-inch thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.
6. Mounting base to secure boiler.

2.3 WATER-JACKETED CONDENSING BOILERS

A. Description: Factory-fabricated, -assembled, and -tested, water-jacketed condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Stainless-steel primary and secondary combustion chamber.

C. Pressure Vessel: Carbon steel with welded heads and tube connections where not in contact with combustion or flue gases.

D. Burner: Natural gas, forced draft; swing-open front and burner observation port.

E. Blower: Centrifugal fan, forced draft. Include prepurge and postpurge of the combustion chamber.
1. Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.

G. Ignition: Electric-spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

H. Casing:
1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Powder-coated protective finish.
4. Insulation: Minimum 4-inch thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.
6. Mounting base to secure boiler.

2.4 TRIM

A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."

B. Aquastat Controllers: Operating**,** firing rate, and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS ¾ hose-end gate valve.

2.5 CONTROLS

A. Refer to Section 230900 "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:
1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Sequence of Operation: Micro-processor based operating on BACNet, MODBus or LONTalk protocol, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature or as determined by building automation system (BMS).
    a. Master Boiler Control Panel: Factory programmed firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

C. Building Automation System Interface: Factory installed hardware and software to enable building automation system to monitor, control, and display boiler status and alarms thru RS-485 port.
1. Hardwired Points:
    a. Monitoring: On/off status, common trouble alarm and low water level alarm.
    b. Control: On/off operation, hot water supply temperature set-point adjustment.
2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.4 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
1. House in NEMA 250, Type **1** enclosure.

2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Field power interface shall be to single point connection, nonfused disconnect switch.
4. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
5. Provide each motor with overcurrent protection.

2.5 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.6 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Equipment Mounting: Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in Division 03.
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high and extend base not less than 4 inches in all directions beyond the maximum dimensions of boiler.
3. Minimum Compressive Strength: 4500 psi at 28 days.

4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install acid neutralizing canister from condensate drain of each boiler and run piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

E. Connect hot-water piping to supply- and return-boiler connections with shutoff valve and flanged connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting:
1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections. Comply with requirements in Section 235100 "Breechings, Chimneys, and Stacks."

H. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
   3. Perform field performance tests to determine capacity and efficiency of boilers.
      a. Test for full capacity.
      b. Test for boiler efficiency at 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
   4. Repeat tests until results comply with requirements indicated.
   5. Provide analysis equipment required to determine performance.
   6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
   7. Notify Architect in advance of test dates.
   8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Training session shall be video taped by Contractor. Refer to Division 01 for other requirements for "Demonstration and Training."

END OF SECTION 235216

N:\N0912.00\DOC\SPEC\2012_03-16_BID\235216 FL - CONDENSING BOILERS.DOC

SECTION 235700 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes plate heat exchangers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which heat exchangers will be attached.

B. Source quality-control reports.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic-water heat exchangers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:

a. Structural failures including heat exchanger, and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.
   a. Plate, Heat Exchangers:
      1) Plate-and-Frame Type: One year(s).

PART 2 - PRODUCTS

2.1 GASKETED-PLATE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alfa Laval Inc.
2. ITT Corporation; Bell & Gossett.
3. Mueller, Paul, Company.
4. Tranter, Inc.

B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.

C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

D. Frame:
1. Capacity to accommodate 20 percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.

E. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.
1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger carrying and guide bars are anchored to building structure.

F. End-Plate Material: Painted carbon steel.

G. Tie Rods and Nuts: Steel or stainless steel.

H. Plate Material: 0.031 inch thick before stamping; Type 316L stainless steel.

I. Gasket Materials: Glue free, Nitrile or EPDM rubber.

J. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

K. Enclose plates in solid aluminum removable shroud.

L. Capacities and Characteristics: As scheduled on plans

2.2 ACCESSORIES

A. Hangers and Supports:
   1. Custom, steel supports for mounting on floor.
   2. Field-fabricated steel supports to ensure both horizontal and vertical support of heat exchanger. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Shroud: Aluminum sheet.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect heat exchangers according to ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME label.

B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Heat exchangers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GASKETED-PLATE HEAT-EXCHANGER INSTALLATION

A. Install gasketed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.

B. Install metal shroud over installed gasketed-plate heat exchanger according to manufacturer's written instructions.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping."

C. Maintain manufacturer's recommended clearances for, service, and maintenance.

D. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

E. Install shutoff valves at heat-exchanger inlet and outlet connections.

F. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

G. Install hose end valve to drain shell.

H. Install thermometer on heat-exchanger and inlet and outlet piping. Comply with requirements for thermometers specified in Section 230519 "Meters and Gages for HVAC Piping."

I. Install pressure gages on heat-exchanger piping. Comply with requirements for pressure gages specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Heat exchanger will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 235700

N:\N0912.00\DOC\SPEC\2012_03-16_BID\235700 FL - HEAT EXCHANGERS FOR HVAC.DOC

SECTION 236416 – AMMONIA SCREW CHILLERS

PART 1 - GENERAL

1.1 PROJECT LOCATION

A. The project location is Montgomery College – Germantown-Maryland Bioscience Center. The following specifications and drawings define the scope of work.

1.2 SCOPE OF WORK

A. Equipment Manufacturer shall furnish all labor, material, equipment and services including all piping and accessories as shown on the drawings and called for in these specifications or as required for delivery of a complete and functioning chiller skid package.

B. The scope of work is to deliver to the site one rotary screw compressor chiller skid package. The skid package shall be designed to operate with R-717 as the refrigerant. The package shall provide a minimum of 250.0 tons of cooling in the chiller mode.
   1. Loading and transportation of the skid package to the site. The Controller will rig the skid package into the Equipment Room.
   2. Frick RWBII screw compressor package with demand oil pump, premium efficiency motor suitable for variable frequency drive, and a plate and frame water cooled oil cooler.
   3. Variable frequency drive with by-pass contactor and main circuit breaker disconnect. The variable frequency drive shall be mounted on the chiller package.
   4. Laser welded plate and frame water-cooled condenser with pilot high pressure receiver and associated piping and valves as shown on the drawings.
   5. Laser welded plate and frame propylene glycol chiller with surge drum, oil pot, and associated piping and valves as shown on the drawings.
   6. Supply and install all isolation valves, relief valves, control valves, and auxiliaries required for a safe and automatically controlled skid package.
   7. Supply and install all piping as shown on the drawings and listed below:
      a. Refrigerant and oil piping.
      b. Relief piping.
   8. Supply and install full charges of R-717 refrigerant and compressor oil as recommended by the compressor manufacturer.
   9. All control wiring for the following items; propylene glycol supply temperature capacity control probe, propylene glycol return temperature probe, refrigerant high pressure liquid temperature probe, refrigerant solenoid valves, and high level cutout float switch and pilot receiver electronic level control.
   10. All power and control wiring between the variable frequency drive and the compressor package.
   11. All equipment, piping, and controls shall be mounted and supported on a structural steel base. The skid package may need to be shipped partially disassembled as required to pass through an opening in the equipment room.
   12. Shop painting and touch-up painting of all equipment and piping.
   13. Supply and install all pipe and vessel insulation with protective coverings in accordance with manufacturers recommendations.
   14. Supply and install all pipe, vessel, and heat exchanger supports as required.
   15. Provide start-up and demonstration services.

16. Provide a minimum of 16 hours of training for at least six college technicians in the operation and maintenance of the package. The training shall be split equally between classroom training and field training. The classroom will be provided by Montgomery College.
17. Provide shop drawing submittals, instruction manuals, and final record documents.
18. Supply and install condenser water flow switch, compressor oil cooling water flow switch, and glycol flow switch. Control wiring to interlock these switches to the screw compressor shall also be installed.

C. Items furnished in other sections of Division 23:
1. Condenser water piping, valves, pumps, and cooling towers.
2. Compressor oil cooler water pipe, valves, or pumps.
3. Chiller glycol pipe, valves, and pumps.
4. Relief piping from the skid package to atmosphere.
5. Power wiring to the variable frequency drive.
6. Water treatment systems.
7. Floor drains, hub drains and associated under floor piping.
8. Control or communications wiring between the skid package and building automation system.
9. Control wiring for the R-717 leak detection system, cooling tower fans, condenser water pumps, glycol pumps, and compressor oil cooler water pumps.
10. Motor starters, contactors and disconnects for cooling tower fans, condenser water pumps, glycol pumps, and the compressor oil cooler water pump.
11. Compressor room ventilation and safety equipment.

1.3 CODES AND STANDARDS

A. The entire refrigeration system, including work and materials, shall be in strict accordance with applicable codes, regulations, and/or authorities having jurisdiction.

1.4 SUBMITTALS

A. Submittals shall be provided in a timely manner. If such material or equipment differs in any way from that described herein, the Owner reserves the right to refuse substitutions.

B. Six (6) copies of shop drawings covering all major equipment and materials shall include the following; compressor package, compressor motor, compressor variable frequency drive package, plate and frame water cooled condenser, pilot receiver, plate and frame propylene glycol chiller, surge drum, isolation valves, control valves, insulation materials, and float switches. All shop drawings shall contain manufacturer's name, model number, electrical data, and capacity data. All shop drawings for major equipment shall be submitted prior to fabrication.

C. Six (6) copies of installation drawings shall also be prepared by the Contractor and submitted to the Architect for approval. Installation drawings shall include; dimensional drawings of the skid package, a piping and instrumentation diagram of the skid package, and a control wiring diagram of the skid package.

D. Each shop drawing shall be certified as being checked and approved by the Architect before being submitted to the Contractor.

E. Two (2) copies of instruction manuals shall be submitted to the Architect. This manual shall include installation instructions, manufacturer's literature for maintenance and operating instructions of the major equipment, lubrication instructions, recommended spare parts and replacement parts lists, performance tables or curves for all compressors, condensers, chillers, pumps, etc.

F. Two (2) copies of "Final Record Documents" shall be submitted to the Architect showing any changes made during construction.

PART 2 - MATERIALS

2.1 WATER COOLED ROTARY SCREW COMPRESSOR PACKAGE

A. Frick Model **RWBII** refrigeration screw compressor unit designed to provide scheduled capacity when absorbing with R717 at 100.0% capacity. This rating is based upon 21.0°F SST and 100.0°F SDT with 10.0°F of non-useful suction superheat and 0.0°F sub-cooling in the condenser and provide 250TR when absorbing with R717 at 100.0% capacity. This rating is based upon 35.0°F SST and 100.0°F SDT with 10.0°F of non-useful suction superheat and 0.0°F sub-cooling in the condenser. Each screw compressor unit will be completely factory wired, piped, pressure tested, and includes the following items factory mounted (unless indicated otherwise):

1. Rotary screw compressor with automatic continuous variable capacity control and “Volumizer” volume ratio control.
2. Oversized 5.0in suction shutoff valve with check valve and suction strainer (ships loose).
3. Standard 3.0in discharge shutoff valve with check valve and cold start valve.
4. Standard oil separator with sump, oil heaters, dual relief valve assembly, and access cover for replacement of internal coalescing element(s).
5. The oil separator is designed and constructed in accordance with ASME Section VIII, Div 1 for maximum design working pressure of 300psi.
6. High capacity SuperFilter II oil filters 5 micron filters with isolation valves.
7. One (1) extra set of SuperFilter II oil filters ship loose.
8. Quantum LX microprocessor in NEMA 4 enclosure.
9. Compressor is coupled to the motor with a flexible coupling.
10. Wiring harness consisting of AC and analog wiring.
11. Oil cooling
12. Frick #3 oil
13. Water-cooled oil cooler to be plate and frame design.
14. Three-way oil temperature control valve
15. Motor: RAM Inverter Rated, 5:1
16. ODP, 40C ambient, NEMA design B, Class F insulation, 1.15 SF, low noise, 95% efficiency, 460 volt / 60 Hz operation.
17. Options Included:
    a. RAM Enhancer II Air-cooled drive (shipped loose) to be mounted on skid. NEMA 1 Enclosure, IEEE519.
    b. Filters in separate NEMA 1
    c. Oversized suction valve to reduce pressure drop.
    d. 1.0in isolation valve for pump out connection downstream of the oil separator coalescers
    e. Frick #3 oil (ships loose)
18. Temperature capacity control allows the compressor to operate on temperature or pressure control, selectable via the microprocessor control keypad
19. Input to setback pressure/temperature control via a digital input to switch between different capacity control modes.
20. Second analog input/output board.
21. Entering process temperature monitoring provides hardware and software to monitor the entering process temperature.
22. Set points available to select alarm and shutdown parameters.

B. One Frick RWBII screw compressor package shall be installed on the skid complete with the following major components; positive displacement twin rotor screw compressor direct driven at 3550 nominal RPM, premium efficiency motor, variable frequency drive, variable volume ratio control, Quantum LX control panel with remote communications and control capability, OSHA approved drive coupling and guard, demand oil pump, 5" suction and 3" discharge stop valves, and 3" discharge check valves, suction scale trap/strainer, oil separator with heaters and initial oil charge, plate and frame water cooled oil cooler, three-way oil temperature control valve, temperature capacity control based on ethylene glycol supply temperature, oil filter assembly with one extra set of oil filter cartridges, and pressure relief valves. The above components, except the variable frequency drive, shall be factory wired, piped, tested, painted, and assembled on a structural steel base. All factory piping shall be performed in accordance with the latest ANSI B31.5 code for pressure piping.

C. R-717 capacity shall be 250 tons of refrigeration when operating at a +35°F saturated suction temperature and a +100°F saturated condensing temperature. The above ratings are based on 0°F of condenser subcooling and a non-useful suction gas superheat of 10°F.

D. The screw compressor casting shall be designed and tested per the requirements of ASHRAE 15 safety code for a maximum discharge pressure of 350 PSIG.

E. The rotors shall be precision machined to meet the tolerances of the latest SRM asymmetric profile.

F. The rotor antifriction bearings shall have a rated bearing life in excess of 100,000 hours at design operating conditions and shall be arranged for continuous lubrication.

G. The mechanical shaft seal shall be a single face type with a spring loaded carbon stationary surface riding against a cast iron rotating seat. The seal shall be capable of sealing up to 350 PSIG. Shaft seals shall be vented to low pressure to extend the life of the seal.

H. Variable volume ratio control shall be furnished with a range 2.2 Vi to 5.0 Vi.

I. Automatic capacity control shall be furnished to provide full modulating capacity control from 100% to approximately 10% of full load. This control shall be achieved by time proportional signals sent from the compressor microprocessor control panel. Temperature capacity control based on the ethylene glycol supply temperature shall be furnished. The standard suction pressure capacity control feature will not be operable for this application. However, a low suction pressure safety override shall be provided to stop loading or force unload the compressor.

J. The lubrication system shall be furnished with a demand oil pump with close coupled motor, suction strainer, bypass check valve, and isolation valves. The pump shall cycle off automatically when not required. A differential pressure cutout shall be provided. A three-way bellows operated oil temperature control valve shall be furnished to prevent low oil temperature.

K. The compressor package shall be furnished with a three-stage horizontal oil separator with integral sump and 1" valved pumpout connection. Two sight glasses shall be located in the reservoir section and one in the coalescing section. The separator shall be designed and constructed in accordance with ASME Section VIII, Division 1 with a maximum design working pressure of 300 PSIG and shall be furnished with a dual relief valve assembly. Two 500 watt heaters shall maintain oil temperature at +67°F during compressor shutdown. The heaters shall be replaceable without shutting down the compressor.

L. The compressor separator shall be furnished with coalescent separator elements capable of final oil / gas separation of particles down to less than 1 micron. An access manway shall be furnished to allow replacement of the internal coalescing elements.

M. Lubrication and injection oil for the compressor shall pass through a multi-cartridge, 15 micron, oil filter assembly complete with isolation and drain valves.

N. The compressor package shall be furnished with a plate and frame water cooled oil cooler. The cooler is designed and constructed in accordance with ASME Section VIII, Division 1 with a MAWP of 300 PSIG on the oil side and 150 psig on the water side. Oil temperature is maintained between 110°F and 130°F for ammonia and halocarbons with a thermally controlled valve. The oil cooler is mounted on the unit with the oil piping connected. Water connections and controls are field installed.

O. A Frick "Quantum LX" control system shall be factory installed on the compressor package. The microprocessor control system shall be completely piped and wired with all necessary safety and operating devices. The NEMA 4 control panel shall house the microprocessor and electrical terminals for field wiring. All transducers shall be wired and piped into a common manifold. A customized communications interface package shall be provided for connection to an existing building automation system and / or a standard modem. The following features shall be provided as a minimum to monitor and control the complete chiller package through the building automation system:

1. The microprocessor shall be capable of transmitting the following analog information to the building automation system or remote computer via an RS-422 communications cable:
    a. Suction pressure.
    b. Discharge pressure.
    c. Oil pressure.
    d. Oil filter pressure.
    e. Oil separator temperature.
    f. Inlet oil temperature.
    g. Discharge temperature.
    h. Suction temperature.
    i. Propylene glycol supply temperature.
    j. Propylene glycol return temperature.
    k. Saturated condensing temperature.
    l. Slide valve position.
    m. Motor current (%).
2. The microprocessor shall be capable of transmitting the following status information to the building automation system or a remote computer:
    a. Ready to start (contact closure output).
    b. Safety alarm condition (contact closure output).
    c. Cycling shutdown condition (contact closure output).
3. The microprocessor shall be capable of accepting the following setpoints from the building automation system or a remote computer:
    a. Propylene glycol supply temperature setpoint for ice building mode. Must be able to switch between set point for ice building mode (+32.0°F to +22.0°F) and set point for system cooling mode (+56.0 to +40°F).
    b. Motor current limit set point. The building automation system must be able to limit motor current between 0% and 100% during pulldown or under normal operating conditions.
4. The microprocessor shall be capable of accepting the following commands from the building automation system or a remote computer:
    a. Set compressor to remote control operation.
    b. Set compressor to local control operation.
5. The communications package shall include documentation describing how to send and retrieve the above information.

P. The following indications or readouts shall be displayed; suction pressure and temperature, ethylene glycol supply and return temperatures, discharge pressure and temperature, saturated condensing temperature via a temperature probe in the condenser high pressure liquid drain line, oil pressure and temperature, filter

pressure drop, slide valve position and mode, volume ratio position and mode, oil pump on / off, % full load motor amps, compressor operating hours, number of compressor starts, and compressor operating mode. The continuous status display shall also indicate that an alarm condition exists or other messages as required.

Q. The microprocessor shall display all fixed and adjustable setpoints and safeties as follows; suction pressure override, glycol supply temperature capacity control, low suction pressure alarm and cutout, motor recycle delay time, current transformer factor, motor current limit (%), motor controller fault, high discharge pressure alarm and cutout, oil heater temperature control, oil cooling temperature control, high oil filter pressure drop alarm, high discharge temperature alarm and cutout, high oil temperature alarm and cutout, high oil pressure alarm and cutout, low oil temperature alarm and cutout, low oil pressure alarm and cutout, glycol "no flow" cutout, condenser water "no flow" cutout, oil cooler water "no flow" cutout, and high motor current cutout.

R. The microprocessor shall display and store the cause, day, date and time of occurrence of an alarm or cutout condition. In the event of a cutout condition, the operating conditions at the time of the cutout shall be stored and available to the operator on a separate freeze display screen. A pre-alarm annunciation on all vital functions shall give warning of a potential shutdown condition.

S. The microprocessor shall reset a time proportioning capacity control at varying time intervals corresponding to deviations from compressor setpoints to provide stable operation under widely changing load conditions. The microprocessor shall also monitor operating conditions and adjust the compressor to operate at the most efficient volume ratio at both full and part load conditions. The microprocessor shall be programmable to automatically change the glycol temperature (automatic setback) setpoint based on a preset time schedule entered into the microprocessor by the operator. An access code protection system shall be furnished to allow only authorized personnel to vary the adjustable setpoints. However, setpoint display shall be available without the access code. The microprocessor panel shall also include a clearly marked emergency stop button.

T. The compressor manufacturer shall furnish start-up service and supervision for the compressor package. This shall include all labor, materials, tools, meals, lodging and transportation for a factory start-up representative to be on the job for a minimum of three working days.

U. The compressor package shall be furnished with a factory mounted open drip proof motor suitable for inverter duty. The motor shall be NEMA premium efficiency, 460 volt / 3Ø / 60 hertz input, with a 1.15 service factor.
   1. The motor shall meet or exceed NEMA Premium Efficiency standards.
   2. An oversized motor junction box shall be furnished to accommodate power feed connection.
   3. Compressor motor shall be RAM, Toshiba, Westinghouse, or approved equal.

V. The compressor package shall be furnished with a variable frequency drive complete with a solid state by-pass contactor.
   1. Requirements:
      a. The drive shall accept 460 volt / 3Ø / 60 hertz input.
      b. The controls shall be housed in a NEMA 1 indoor enclosure.
      c. A control circuit transformer individually fused shall provide 120 volt / 1Ø / 60 hertz power to the compressor microprocessor panel and oil heaters.
      d. A 460 volt / 3Ø / 60 hertz across-the-line motor starter shall be provided for the compressor oil pump.
      e. A compressor motor current transformer shall signal the microprocessor control panel if the motor exceeds its preset load limits.
      f. A 500% maximum current limiter and current override adjustable voltage ramp shall be furnished.
      g. The drive shall include; undervoltage protection, overvoltage protection, phase loss protection, phase reversal protection, and all appropriate interlocks and internal wiring. Terminals shall be marked to correspond to the compressor manufacturer's diagrams.

2. The drive shall be mounted on the chiller package.
3. The compressor starter shall be Underwriters Laboratories recognized or CSA certified. The starter package shall be RAM or approved equal.

2.2 PLATE AND FRAME WATER COOLED CONDENSER

A. Laser welded plate and frame water cooled condenser shall be installed on the skid package. The condenser shall be designed and constructed in accordance with ASME Section VIII, Division 1 with a MAWP of 300 PSIG on the refrigerant side and 150 PSIG MAWP on the water side. The unit shall be constructed with corrugated pattern 316 stainless steel plates laser welded together to form cassettes. The cassettes shall be gasketed and compressed into a carbon steel frame with end covers, carrying bar, and tightening bolts. The condenser shall be mounted on the skid package such that plate removal for cleaning will be possible. Maximum water velocity of 12 fps, 0.0005 water side fouling factor, and 15 PSI maximum water pressure drop.

2.3 PLATE AND FRAME PROPYLENE GLYCOL CHILLER

A. One laser welded plate and frame ethylene glycol chiller shall be installed on theskid package. The chiller shall be designed and constructed in accordance with ASME Section VIII, Division 1 with a MAWP of 300 PSIG on the refrigerant side and 150 PSIG MAWP on the propylene glycol side. The unit shall be constructed with corrugated pattern 316 stainless steel plates laser welded together to form cassettes. The cassettes shall be gasketed and compressed into a carbon steel frame with end covers, carrying bar, and tightening bolts. The chiller shall be furnished with a factory supplied insulation and drip tray package. The chiller shall be mounted on the skid package such that plate removal for cleaning will be possible. Flooded R-717 evaporating at 21°F at 4 fps minimum glycol velocity, 12 fps maximum glycol velocity, 0.0005 glycol side fouling factor, and 5 PSI maximum glycol pressure drop.

B. Minimum R-717 performance for chiller mode shall be 249.3 tons of cooling 375 GPM of 30% propylene glycol by volume, +_56°F glycol inlet, +40°F glycol outlet, flooded R-717 evaporating at +35°F.

2.4 PRESSURE VESSELS

A. One glycol chiller surge drum, one oil pot, and one pilot receiver shall be installed on the skid package. All vessels shall be designed and constructed in accordance with Section VIII, Division 1 of the latest ASME code for pressure vessels. Vessels shall be of all steel construction with ASME data plates mounted above the vessel insulation.

B. The vessels shall be furnished with all necessary connections, internal baffles, internal piping, lifting lugs, supports, etc. as required for proper operation. All internal baffling and piping shall be adequately supported to withstand shipment, installation, and continuous streams of gas and liquid.

C. The vessels shall be thoroughly cleaned of welding slag, scale and other foreign matter and shall be thoroughly dried after testing. After testing, all connections shall be capped for shipment.

D. The vessels shall be shop painted, outside only, with two coats of red oxide primer.

E. The glycol chiller surge drum shall have a MAWP of 300 PSIG, the oil pot shall have a MAWP of 400 PSIG, and the pilot receiver shall have a MAWP of 300 PSIG.

F. Pressure vessels shall be Frick, RVS, FES or approved equal.

2.5 REFRIGERANT CONTROLS

A. General:
   1. Refrigerant controls and accessories shall be supplied and installed as shown on the drawings and as specified below. Companion flanges shall be the same size as the adjacent pipe size unless noted otherwise.

B. Solenoid valves:
   1. Solenoid valves shall be of the pilot operated, spring closing, normally closed type with a 120/1/60 VAC watertight coil and pilot light, teflon seats, steel or ductile iron body, stainless steel piston, manual jacking stem. A close coupled 60-mesh strainer complete with socket weld companion flanges when called for on the drawings shall precede solenoid valves.
   2. Solenoid valves and strainers shall be Hansen Technologies, Refrigerating Specialties or approved equal.

C. Float switches:
   1. Float switches shall be suitable for refrigerant service and shall be magnetically actuated, mechanically operated, hermetically seated, with a 120/1/60 VAC SPDT switch and 3/4" FPT / 1" butt weld connections.
   2. Float switches shall be Hansen Technologies (type HLL), Refrigerating Specialties (type LL) or approved equal.

D. Relief valves:
   1. All pressure vessels and heat exchangers shall be equipped with ASME certified relief valves sized and rated in accordance with the latest ASHRAE 15 and ANSI B9.1 code requirements. Dual relief valves shall be required on vessels having an internal volume of 10 cubic feet or more.
   2. Relief valves shall be Hansen Technologies, Refrigerating Specialties, Shank or approved equal.

E. Liquid level bulls eyes:
   1. Liquid level bulls eyes shall be installed as shown on the drawings. Bulls eyes shall be equipped with reflex lenses.
   2. Bulls eyes shall be installed at approximately 12" on center on all float columns. Bulls eyes shall be equipped with saddle milled housings and frost shields where required.
   3. Liquid level bulls eyes shall be HA Phillips, Hansen Technologies or approved equal.

F. Pilot Receiver Level Control:
   1. Danfoss liquid level control system to consist of motorized valve type ICM with ICAD actuator, in-line strainer, AKS41/41U transmitter and probe, solenoid valve, EKC347 liquid level controller, and isolation hand valves all mounted and wired for level control of pilot receiver for high side float control sequence.

G. Hand expansion valves:
   1. Hand expansion valves shall be installed as shown on the drawings. Valves shall have socket weld or butt weld connections.
   2. Valves shall be of the back-seating type for packing replacement and shall have slotted throttling plugs, tight closing teflon seats, stainless steel stems, and bar handles.
   3. Hand expansion valves shall be Hansen Technologies, Refrigerating Specialties or approved equal.

2.6 PIPING SYSTEMS

A. Refrigerant and oil piping:
   1. General:

a. All components in direct contact with ammonia SHALL NOT contain copper, brass, mercury or alloys of these materials.
b. All materials used in the system shall be suitable for R-717 service, and shall comply with the latest ANSI/ASME B31.5 Code for Pressure Piping and meet system pressure-temperature requirements.

2. Piping:
   a. Lines 1-1/2" and smaller shall be schedule 80, A-106B seamless black steel pipe.
   b. Lines 2" and larger shall be schedule 40, A-53B electric resistance welded black steel pipe.
3. Joints:
   a. Joints in lines 1-1/2" and smaller shall be 3000# forged steel socket weld couplings. Joints in lines 2" and larger shall be butt welded. Where screwed joints on gauges, etc. are necessary, joints shall be made using Expando joint compound. Screwed joints shall be avoided wherever possible.
4. Fittings:
   a. Fittings for 1-1/2" and smaller pipe shall be 3000# forged steel socket welded. Fittings for 2" and larger pipe shall be butt welded.
5. Refrigerant shutoff valves:
   a. All valves shall be of the globe or angle type as shown on the drawings. Valves 2-1/2" and smaller shall have socket weld connections. Valves 3" and larger shall have butt weld connections. All valves shall be Hansen Technologies, Refrigerating Specialties or approved equal.
   b. All isolating valves shall be full line size of piping and furnished with hand wheels. Angle valves shall be used wherever possible.

PART 3 - EXECUTION

3.1 PIPING

A. Piping of the plate and frame heat exchangers must be routed to facilitate easy cleaning and removal of the plates.

B. Welded joints shall be made only by certified welders thoroughly experienced in welding on pressure piping systems. All welded joints shall be made in such a manner that the inside of the pipe is relatively free from welding slag, scale and drippings.

C. Long radius elbows shall be used to minimize pressure drops.

D. All piping shall be fabricated, installed, supported and tested in accordance with the latest edition of the American National Standard Code for Pressure Piping ANSI B31.5.

3.2 PAINTING

A. After the skid package is set in place by the Owner and ready for operation, the Contractor shall touch-up all equipment and piping that has become marred during shipping or installation.

B. The Contractor shall also paint all un-insulated pressure vessels, un-insulated black steel pipe, and steel supports supplied by the Contractor.

3.3 EVACUATION AND VACUUM DEHYDRATION

A. After pressure testing the skid package for leaks, the skid package shall be evacuated to remove air and moisture. The package shall be evacuated down to a minimum of 10,000 microns. Break the vacuum with refrigerant vapor and raise to 20 PSIG as a holding charge until ready to charge the system.

END OF SECTION 236416

N:\N0912.00\DOC\SPEC\2012_03-16_BID\236416 - AMMONIA SCREW CHILLERS.DOC

SECTION 236420- CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.
   2. Packaged, portable refrigerant recovery units.

B. Related Section:
   1. Section 283500 "Refrigerant Detection and Alarm" for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Condenser-Fluid Temperature Performance:
   1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 55 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.

2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 60 deg F.
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

B. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

C. Performance Tolerance: Comply with the following in lieu of ARI 550/590:
1. Allowable Capacity Tolerance: Zero percent.
2. Allowable IPLV/NPLV Performance Tolerance: Zero percent.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of chiller.
5. Oil capacity of chiller.
6. Fluid capacity of evaporator and condenser.
7. Characteristics of safety relief valves.
8. Minimum entering condenser-fluid temperature.
9. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.

B. LEED Submittals:
1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Source quality-control reports.

D. Startup service reports.

E. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 certification program.

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASHRAE Compliance:
1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

E. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.

F. Comply with NFPA 70.

G. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:
    a. Complete chiller including refrigerant and oil charge.
    b. Complete compressor and drive assembly including refrigerant and oil charge.
    c. Refrigerant charge.
    d. Parts and labor.
    e. Loss of refrigerant charge for any reason.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. McQuay International.

2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.
    1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.
    2. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.

B. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

2.3 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Single-stage or multistage, magnetic bearing variable-displacement, centrifugal-type compressor driven by an electric motor.
    1. Provide oil-free compressor technology using a permanent magnet synchronous motor, magnetic bearings, integral variable frequency controller, and digital electronic controls.

B. Compressor:
    1. Casing: Cast iron, precision ground.
    2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.
    3. Bearing: Frictionless magnetic bearings.

C. Drive: Direct, hermetic design using an electric motor as the driver.
    1. Seals: Seal drive assembly to prevent refrigerant leakage.

D. Compressor Motor:
    1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
    2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.

3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. Provide motor with thermistor or RTD in each of three-phase motor windings to monitor temperature and report information to chiller control panel.
5. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.

E. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
1. Overspeed Test: 25 percent above design operating speed.

F. Service: Easily accessible for inspection and service.
1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

G. Economizers: For multistage chillers, provide interstage economizers.

H. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with variable frequency drive, to achieve performance indicated.
1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 15 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature per ARI allowed condenser relief for each 10 percent in capacity reduction.
4. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.

2.4 REFRIGERATION

A. Refrigerant:
1. Type: R-134a; ASHRAE 34, Class A1.
2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

C. Pressure Relief Device:
1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.

E. Refrigerant Isolation for Chillers Using R-134a: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition,

provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

2.5 EVAPORATOR

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Tubes:
1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper-nickel alloy.
4. Nominal OD: 3/4 or 1 inch.
5. Minimum Wall Thickness: 0.025 inch.
6. External Finish: Manufacturer's standard.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:
1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections. Standard type for water box without piping connections.
3. Provide marine water-box with lifting lugs or eyebolts.
4. Nozzle Pipe Connections: Welded, ASME B16.5, raised-face flange.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

2.6 CONDENSER

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

D. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.

E. Tubes:
   1. Individually replaceable from either end and without damage to tube sheets and other tubes.
   2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
   3. Material: Copper-nickel alloy.
   4. Nominal OD: 3/4 or 1 inch.
   5. Minimum Wall Thickness: 0.025 inch.
   6. External Finish: Manufacturer's standard.
   7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:
   1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   2. Marine type for water box with piping connections. Standard type for water box without piping connections.
   3. Provide marine water-box with lifting lugs or eyebolts.
   4. Nozzle Pipe Connections: Welded, ASME B16.5, raised-face flange.
   5. Thermistor or RTD temperature sensor factory installed in each nozzle.
   6. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection:
   1. Electrolytic corrosion-inhibitor anode.
   2. Coat wetted surfaces with a corrosion-resistant finish.
   3. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

2.7 INSULATION

A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Thickness: 2 inches.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
   1. Apply adhesive to 100 percent of insulation contact surface.
   2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
   3. Seal seams and joints to provide a vapor barrier.
   4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

2.8 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to non fused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
   1. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls non fused with disconnect switch or circuit breaker.
      a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
      b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
   2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
   3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring outside of enclosures shall be in metal raceway except make terminal connections with not more than a 24-inch length of liquidtight conduit.

E. Factory install and wire capacitor bank for the purpose of power factor correction to 0.95 at all operating conditions.
   1. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
   2. Capacitors shall be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAr ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
   3. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.
   4. Provide a ground terminal and a terminal block or individual connectors for phase connection.

2.9 VARIABLE FREQUENCY CONTROLLER

A. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

B. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

C. Enclosure: Unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key.

D. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

E. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

F. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
   1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.
   2. Regulator shall provide full digital control of frequency and voltage.
   3. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.

G. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.

H. Operating Requirements:
   1. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum.
   2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
   3. Capable of driving full load, without derating, under the following conditions:
      a. Ambient Temperature: 0 to 50 deg C.
      b. Relative Humidity: Up to 95 percent (noncondensing).
      c. Altitude: 3300 feet.
   4. Minimum Efficiency: 96 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter, 98 percent with harmonic filter.
   6. Overload Capability: 1.05 times the full-load current for 7 seconds.
   7. Starting Torque: As required by compressor-drive assembly.
   8. Speed Regulation: Plus or minus 1 percent.
   9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
   10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
   11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

I. Internal Adjustability Capabilities:
   1. Minimum Output Frequency: 6 Hz.
   2. Maximum Output Frequency: 60 Hz.
   3. Acceleration: 2 seconds to a minimum of 60 seconds.
   4. Deceleration: 2 seconds to a minimum of 60 seconds.
   5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

J. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:
   1. Overtemperature.
   2. Short circuit at controller output.
   3. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
   4. Open circuit at controller output.
   5. Input undervoltage.
   6. Input overvoltage.
   7. Loss of input phase.
   8. Reverse phase.
   9. AC line switching transients.
   10. Instantaneous overload, line to line or line to ground.
   11. Sustained overload exceeding 100 percent of controller rated current.

12. Starting a rotating motor.

K. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

L. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

M. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. Motor speed (percent).
8. Fault or alarm status (code).
9. DC-link voltage.
10. Motor output voltage.
11. Input kilovolt amperes.
12. Total power factor.
13. Input kilowatts.
14. Input kilowatt-hours.
15. Three-phase input voltage.
16. Three-phase output voltage.
17. Three-phase input current.
18. Three-phase output current.
19. Three-phase input voltage total harmonic distortion.
20. Three-phase input current total harmonic distortion.
21. Output frequency (Hertz).
22. Elapsed operating time (hours).
23. Diagnostic and service parameters.

N. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

O. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.

P. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to 5 percent.

Q. Cooling: Refrigerant cooled.

R. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.
1. Control Relays: Auxiliary and adjustable time-delay relays.

S. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

2.10 CONTROLS

A. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

B. Enclosure: Unit mounted, NEMA 250, Type 1, hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.

C. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:
   1. Date and time.
   2. Operating or alarm status.
   3. Fault history with not less than last 10 faults displayed.
   4. Set points of controllable parameters.
   5. Trend data.
   6. Operating hours.
   7. Number of chiller starts.
   8. Outdoor-air temperature or space temperature if required for chilled-water reset.
   9. Entering- and leaving-fluid temperatures of evaporator and condenser.
   10. Difference in fluid temperatures of evaporator and condenser.
   11. Fluid flow of evaporator and condenser.
   12. Fluid pressure drop of evaporator and condenser.
   13. Refrigerant pressures in evaporator and condenser.
   14. Refrigerant saturation temperature in evaporator and condenser shell.
   15. Compressor refrigerant suction and discharge temperature.
   16. Compressor bearing temperature.
   17. Motor bearing temperature.
   18. Motor winding temperature.
   19. Phase current.
   20. Percent of motor rated load amperage.
   21. Phase voltage.
   22. Demand power (kilowatts).
   23. Energy use (kilowatt-hours).
   24. Power factor.
   25. For chillers equipped with variable frequency controllers and harmonic filters, include the following:
      a. Output voltage and frequency.
      b. Voltage total harmonic distortion for each phase.
      c. Supply current total demand distortion for each phase.
      d. Inlet vane position.
      e. Controller internal ambient temperature.
      f. Heatsink temperature.
   26. Purge suction temperature if purge system is provided.
   27. Purge elapsed time if purge system is provided.

D. Control Functions:
   1. Manual or automatic startup and shutdown time schedule.
   2. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator fluid temperature shall be reset based on building automation system (BMS) temperature.
   3. Current limit and demand limit.
   4. Condenser-fluid temperature.
   5. External chiller emergency stop.

6. Thermal storage.

E. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
1. Low evaporator pressure or temperature; high condenser pressure.
2. Low evaporator fluid temperature.
3. Low oil differential pressure.
4. High compressor-discharge temperature.
5. Loss of condenser-fluid flow.
6. Loss of evaporator fluid flow.
7. Motor overcurrent.
8. Motor overvoltage.
9. Motor undervoltage.
10. Motor phase reversal.
11. Motor phase failure.
12. Sensor- or detection-circuit fault.
13. Processor communication loss.
14. Motor controller fault.
15. Extended compressor surge.

F. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

G. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

H. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

I. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

J. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
1. Hardwired Points:
a. Monitoring: On-off status, common trouble alarm, electrical power demand (kilowatts), electrical power consumption (kilowatt-hours) and power factor.
b. Control: On-off operation, chilled-water, discharge temperature set-point adjustment and electrical power demand limit.
2. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

2.11 FINISH

A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
1. Provide at least one coat of primer with a total dry film thickness of at least 2 mils.
2. Provide at least two coats of alkyd-modified, vinyl enamel finish with a total dry film thickness of at least 4 mils.
3. Paint surfaces that are to be insulated before applying the insulation.
4. Paint installed insulation to match adjacent uninsulated surfaces.
5. Color of finish coat to be manufacturer's standard.

B. Provide Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.

2.12 ACCESSORIES

A. Flow Switches:
1. Chiller manufacturer shall furnish a factory furnished and mounted thermal dispersion sensor for each evaporator and condenser and verify field-mounting location before installation.

2.13 PACKAGED REFRIGERANT RECOVERY UNITS

A. Packaged portable unit consisting of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest chiller furnished.

2.14 CAPACITIES AND CHARACTERISTICS

A. Capacity: See plans for chiller schedule.

B. Noise Rating: 85 sound power level when measured according to ARI 575. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

2.15 SOURCE QUALITY CONTROL

A. Perform functional run tests of chillers before shipping.

B. Factory performance test chillers, before shipping, according to ARI 550/590.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.
1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

A. Install chillers on support structure indicated.

B. Equipment Mounting: Install chiller on concrete bases using spring isolators and elastomeric pads. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC Piping and Equipment."
   1. Minimum Deflection: 1/2 inch.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge chiller with refrigerant if not factory installed.

E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve. Make connections to chiller with a flange.

D. Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve. Make connections to chiller with a flange.

E. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend separate vent piping for each chiller to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

F. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions.

END OF SECTION 236420

N:\N0912.00\DOC\SPEC\2012_03-16_BID\236420 FL - CENTRIFUGAL WATER CHILLERS.DOC

SECTION 236500 - COOLING TOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Open-circuit, induced-draft, crossflow cooling towers.

1.3 DEFINITIONS

A. BMS: Building management system.

B. FRP: Fiber-reinforced polyester.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Cooling tower support structure shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
   1. Seismic Loads: Zone 4, Importance factor 1.0.
   2. Wind Loads: 30psf.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.
   1. Maximum flow rate.
   2. Minimum flow rate.
   3. Drift loss as percent of design flow rate.
   4. Performance curves for the following:
      a. Varying entering-water temperatures from design to minimum.
      b. Varying ambient wet-bulb temperatures from design to minimum.
      c. Varying fan operation (off, minimum, and design speed).
   5. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
   6. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:
   1. Assembled unit dimensions.
   2. Weight and load distribution.

3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

D. Certificates: For certification required in "Quality Assurance" Article.

E. Field quality-control reports.

F. Startup service reports.

G. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:
1. Fan assembly including fan, drive, and motor.
2. Leak-free cold water basin.

3. Warranty Period: Five years from date of shipment.

PART 2 - PRODUCTS

2.1 OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

A. Products: Subject to compliance with requirements, provide one of the following:
   1. Baltimore Aircoil Company
   2. Marley Cooling Technologies
   3. Evapco

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:
   1. Casing Material: 304 stainless steel.
   2. Fasteners: Match construction.
   3. Joints and Seams: Sealed watertight.
   4. Welded Connections: Continuous and watertight.

E. Collection Basin:
   1. Material: Welded 304 or 316 Stainless steel
   2. Removable stainless-steel strainer with openings smaller than nozzle orifices.
   3. Overflow and drain connections.
   4. Makeup water connection.
   5. Outlet Connection: ASME B16.5, Class 150 flange.
   6. Equalizer connection for field-installed equalizer piping.
   7. Basin Sweeper Distribution Piping and Nozzles:
      a. Pipe Material: PVC.
      b. Nozzle Material: Plastic.
      c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.

F. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
   1. Enclosures: NEMA 250, Type 4.
   2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve.
   3. Electrode Probes: Stainless steel.
   4. Water Stilling Chamber: PVC pipe.
   5. Solenoid Valve: Slow closing, controlled and powered through level controller in response to water-level set point.
   6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Electric Basin Heater:
   1. Copper Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
   2. Provide low water cutout and thermostat installed in cooling tower basin.

H. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.
   1. Material: Galvanized steel, ASTM A 653/A 653M, G235 coating.
   2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
   3. Inlet Connection: ASME B16.5, Class 150 flange.
   4. Joints and Seams: Sealed watertight.
   5. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant hardware.
   6. Single-Inlet, Field Pipe Connection: PVC pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the side unless otherwise indicated.

I. Fill:
   1. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E 84.
   2. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

J. Drift Eliminator:
   1. Material: PVC; with maximum flame-spread index of 25 according to ASTM E 84.
   2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
   3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
   4. Location: Integral to fill.

K. Air-Intake Louvers:
   1. Material: FRP.
   2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
   3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
   4. Location: Separate from fill.

L. Removable Air-Intake Screens: Aluminum steel wire mesh.

M. Axial Fan – Low Noise: Balanced at the factory after assembly.
   1. Blade Material: Aluminum.
   2. Hub Material: Aluminum.
   3. Blade Pitch: Field adjustable.
   4. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
   5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 40,000 hours.
   6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

N. Belt Drive:
   1. Service Factor: 1.5 based on motor nameplate horsepower.
   2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
   3. Belt: One-piece, multigrooved, solid-back belt.
   4. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.

5. Belt-Drive Guard: Comply with OSHA regulations.
6. Inverter duty for Variable Speed Drive application.

O. Fan Motor:
1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed air over (TEAO
3. Energy Efficiency: Comply with ASHRAE/IESNA 90.1, NEMA Premium Efficient.
4. Service Factor: 1.0
5. Insulation: Class F
6. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
7. Motor Location: Mounted inside cooling tower.

8. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

P. Vibration Switch: For each fan drive.
1. Enclosure: NEMA 250, Type 4.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0.2 to 2.0 g and frequency range of 0 to 3600 RPM. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

Q. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

R. Control Package: Factory installed and wired, and functionally tested at factory before shipment.
1. NEMA 250, Type 3R enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Collection basin level controller complying with requirements in Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve Paragraph.
6. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
7. Vibration switch for each cell, complying with requirements in "Vibration Switch" Paragraph.
8. Single-point, field-power connection to a circuit breaker for each cooling tower cell.
   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
   b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated. VFD shall be mounted in panel.
9. Field-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
10. Visual indication of status and alarm with momentary test push button for each motor.
11. Visual indication of elapsed run time, graduated in hours for each motor.
12. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:

a. Operational status of each motor.
b. Position of dampers.
c. Fan vibration alarm.
d. Oil-level alarm.
e. Collection basin high- and low-water-level alarms.

S. Personnel Access Components:
1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. Handrail: Galvanized steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.
4. Internal Platforms: Galvanized-steel bar grating.
a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
5. Provide motor davits for each cell.

T. Capacities and Characteristics: As scheduled on plans.
1. Number of Cells: 2
2. Air-Inlet Arrangement: Two sides.
3. Maximum Drift Loss: 0.005 percent of design water flow.
4. Basin Heater:
a. Basin Water Temperature: 40 deg F
b. Outdoor Ambient Temperature: 0 deg F

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.
1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cooling towers on support structure indicated.

B. Equipment Mounting: Install cooling tower using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."
   1. Minimum Deflection: 1 inch.
   2. Provide galvanized-steel plate to equally distribute weight over elastomeric pad.

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to cooling towers to allow service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Provide drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

F. Domestic Water Piping: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.

G. Supply and Return Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a flange coupling.

H. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform field tests and inspections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections.

C. Cooling towers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.
   1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
      a. Clean entire unit including basins.
      b. Verify that accessories are properly installed.
      c. Verify clearances for airflow and for cooling tower servicing.
      d. Check for vibration isolation and structural support.
      e. Lubricate bearings.
      f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
      g. Adjust belts to proper alignment and tension.
      h. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
      i. Check vibration switch setting. Verify operation.
      j. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
      k. Verify operation of basin heater and control.
      l. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
      m. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.6 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION 236500

N:\N0912.00\DOC\SPEC\2012_03-16_BID\236500 - COOLING TOWERS.DOC

SECTION 236510 – ICE STORAGE TANKS

PART 1 - GENERAL:

1.1 SECTION INCLUDES

A. Ice storage tanks

1.2 SUBMITTALS

A. Submit shop drawings under provisions of Division 01.

B. Submit shop drawings indicating components, assembly, dimensions, required clearances, and location and size of field connections. Indicate equipment, piping, connections, and valves required for complete system.
   1. Submit complete shop drawing of manifold piping.

C. Submit product data under provisions of Section Division 1.

D. Submit product data indicating total latent and sensible capacities, weight, maximum operating temperature, factory test pressure, maximum operating pressure, specialties and accessories.

E. Submit manufacturer's installation instructions under provisions of Section Division 1.

1.3 OPERATION AND MAINTENANCE DATA

A. Submit operation data under provisions of Section Division 1.

B. Include start-up instructions, maintenance data and parts lists and accessories.

C. Submit maintenance data under provisions of Division 1.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery products to site provisions of Division 1.

B. Store and protect products under provisions of Division 1.

C. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

D. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.5 WARRANTY

A. Provide factory warranty under provisions of Division 1 and as required as part of the section.

B. Warranty: Include coverage for heat exchanger, container and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Baltimore Air Coil Thermal Storage Unit

B. Warranty: Ten year warranty on tanks.

2.2 ICE THERMAL STORAGE UNITS

A. The ICE CHILLER® Thermal Storage Unit(s) shall be Baltimore Air coil Company Model TSU. Each unit shall have a latent ton-hour storage capacity as shown on the schedule. Rated system performance shall be provided in the format recommended by the Air-Conditioning & Refrigeration Institute (ARI) Guideline T. The thermal storage units shall be modular in design. Unit design shall allow units of different sizes to be installed in order to optimize unit selection and minimize space requirements. Tanks sizes can be mixed due to internal piping arrangements that create a balanced flow due to uniform pressure drop through the coil circuits.

B. The tank shall be constructed of heavy-gauge galvanized steel panels and include double brake flanges for structural strength. The tank walls shall be supplied with a minimum of 4-1/2" of insulation that provides a total insulating value of R-18. The tank design shall utilize multiple liners. The primary liner, which forms the interior of the unit, shall be of single piece construction and be suitable for low temperature applications. The secondary liner/vapor barrier shall be separated from the primary liner by 1-1/2" of extruded polystyrene insulation. The tank bottom shall be insulated with 2" of expanded polystyrene insulation and 1" of extruded polystyrene insulation.

C. The ICE CHILLER® Thermal Storage Unit shall be provided with watertight, sectional covers constructed of hot-dip galvanized steel. The covers shall be insulated with a minimum of 2" of expanded polystyrene insulation.

D. Contained within the tank shall be a steel heat exchanger that is constructed of 1.05" O.D., all prime surface serpentine steel tubing encased in a steel framework. The coil, which is hot-dip galvanized after fabrication, shall be pneumatically tested at 190 psig and rated for 150 psig operating pressure. The coil circuits are configured to provide maximum storage capacity. The coil connections on the unit are galvanized steel and are grooved for mechanical coupling.

E. Each ICE CHILLER® Thermal Storage Unit shall be provided with a sight tube. The sight tube, which shall be fabricated from clear plastic pipe, shall display the tank water level and corresponding ice inventory.

F. Operating controls, consisting of two float switches, shall be mounted on the outside of the tank. The high level float switch terminates the build cycle when the tank water level reaches the 100% ice build level. The high level switch shall also prevent re-initiation of the build cycle until approximately 15% of the ice has been discharged. The second float switch is a low water cutout. The cutout requires that the water level in the ICE CHILLER® Thermal Storage Unit be at or above the 0% ice build level before the ice build cycle can begin. Operating control quantities vary based on project requirements. An optional differential pressure transmitter shall be available to supply an electrical output signal proportional to the amount of ice in inventory.

G. The heat transfer fluid shall be an industrially inhibited, 30% by weight, propylene glycol solution specifically designed for HVAC applications. The 30% (by weight) solution is designed to provide freeze/burst and corrosion protection as well as efficient heat transfer in water based, closed loop systems.

Corrosion inhibitors shall be provided to keep pipes free of corrosion without fouling. DOWTHERM® SR-1 and UCARTHERM® are acceptable fluids.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturers instruction.

B. Place modular tank units on concrete pad as indicated on the drawings. Care must be exercised so as not to drop and/or damage tanks. Tanks that are dropped or damaged to the extent that the warranty is voided shall be replaced at no cost to the owner.

C. Provide main header piping as indicated on the drawings.

D. Install inventory meter, air pumps, make-up water and other accessories indicated on the drawings.

E. Air pressure test tanks and headers to 90 PSI in accordance with manufacturer's instruction. Correct leaks and re-test until pressure test is successful.

F. After successful pressure test, insulate piping as required under section 230700.

G. Charge system with solution of seven parts water and three parts propylene glycol (30 percent mixture). Thoroughly mix solution in a separate container before charging into system. Remove all air from the system.

H. Use propylene glycol manufactured by DOW Chemical (SR-1), Union Carbide (UCATHERM) or approved equal. Add the manufacturer recommended amount anti-foaming agents.

I. After the system is fully charged, circulate for 24 hours. Test the solutions glycol concentration by using a refractometer or equivalent methods. Draw off a sufficient amount of the solution and add propylene glycol or water as required to achieve a 30 percent propylene glycol solution.

J. Adjust and verify that inventory meters perform manufacturer's instructions.

3.2 DEMONSTRATION

A. Demonstrate system operation and maintenance to owner's representative under provisions of Section 230593 and Division 1.

END OF SECTION 236510

N:\N0912.00\DOC\SPEC\2012_03-16_BID\236510- ICE STORAGE TANKS.DOC

SECTION 236513 - GLYCOL HEAT TRANSFER FLUID

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the providing of a premixed glycol solution comprised of 3 parts water to 2 parts inhibited propylene glycol (30 percent mixture) for the glycol chilled water system.

1.2 SUBMITTALS

A. Refer to Section 23 0000.

B. Submit product data: proposed glycol mixture, manufacturers' certificate of analysis, jobsite fluid concentration test, and requirements for installation.

1.3 QUALITY ASSURANCE

A. All components such as pumps and valves: suitable for use with the acceptable heat transfer fluid.

B. Comply with all applicable codes in the transportation, use and disposal of the heat transfer fluid.

C. Provide the system with a (eight-inch by ten-inch) metal nameplate containing the following information:
   1. Date of original heat transfer fluid charge.
   2. Description of heat transfer fluid.
   3. Manufacturers name, address and telephone number.
   4. Percent of glycol.
   5. Estimated freeze point at concentration.
   6. Minimum concentration to provide burst protection.
   7. Total system volume.
   8. Reference to material safety data sheet.
   9. Instructions for sampling fluid.

1.4 DELIVERY

A. Deliver the glycol in 55-gallon drums or, if the system is larger, by tanker truck.

1.5 WARRANTY

A. Refer to Section 23 0000.

PART 2 - PRODUCTS

2.1 PROPYLENE GLYCOL-BASED PRODUCT

A. Provide a heat transfer fluid that is an inhibited propylene glycol-based heat transfer fluid specifically formulated for use in HVAC systems. Provide the fluid with corrosion inhibitors and buffers necessary for long fluid and system life. Provide the fluid with a fluorescent dye to aid in

leak detection. Provide an inhibitor level equivalent to the level found in a minimum 30% concentration of inhibited glycol.

B. Provide for 30 percent solution of heat transfer fluid and deionized water, premixed by the chemical manufacturer before delivery, having a freeze point of +10 degrees F. Water quality:

C. Sulfate and Chloride <25 ppm

D. Sodium <50 ppm

E. Magnesium and Chloride <1 ppm

F. Require the manufacturer to provide, at no charge, an annual solution laboratory analysis that accurately reports propylene glycol concentration, freeze point temperature, inhibitor level, alkalinity, particulates, and recommended additions to glycol, inhibitor and buffers to ensure a twenty year minimum life.

G. Field or distributor mixed fluid, automotive antifreeze, uninhibited glycol, or field or distributor inhibited glycol is not acceptable.

H. Manufacturers: Subject to compliance with requirements, provide factory pre-mixed propylene glycol:

I. Dow Chemical Co. "Dowfrost”

J. Interstate Chemical Co. NFP

K. PVS – Nolwood Chemical “PVC Chill PGHD”

L. Union Carbide Corp. "Foodfreeze”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hydrostatically test and clean the system prior to system fill of heat transfer fluid. Remove dirt, weld slag, filings, oil, etc., and flush from system prior to final fill. Isolate all heat transfer equipment while the field piping is being flushed. Completely drain the system.

B. Refill the system with fresh water and add 4% by volume of system cleaner PVC CLP or equivalent. Circulate the system at ambient temperature 48 hours.

C. Check with local sewer discharge requirements, if acceptable; drain the system to the sewer. Do not under any circumstance drain to waterway or open drainage ditch. If discharge requirements do not allow for sewer discharge, call approved licensed water disposal contractor.
   1. Approved Disposal Contractors
      a. Dynecol
      b. Northpointe Transfer LLC

D. Compare the final flush with the initial fill and identify how much water is trapped in the system. Calculate the proper premixed concentration and volume required for final operating specified concentration for the system.

E. Furnish 2 empty new drums on the jobsite before fill to accommodate any overage.

F. In cases of bulk fill by tank truck, provide for the glycol manufacturer to send a qualified technician to the job site to meet the contractor site supervisor and agree on a plan and required equipment that will maximize the time efficiency and safety of the filling process.

G. On the date of the system fill by bulk tank truck, provide for a qualified technician to be supplied by the glycol manufacturer to be on site to work with the contractor to maximize time efficiency and safety of the filling process. Provide for this person to also have with them spill containment media.

H. Pump the premixed heat transfer fluid into a 50-mm (2-inch) fill connection on the suction side of the pump. Position a 2-inch ball valve between the filling connection and the system as a method of preventing backfill into the delivery vehicle, should the filling process need to be interrupted during the fill. Before starting the filling pump, open high point vents. Man these vent locations at all times during the filling process so that the heat transfer fluid solution is not spilled.

I. When the heat transfer mixture reaches the vent, manually close the vent and stop the fill pump. Take care not to over pressurize the system.

J. Turn the system pump on for a few minutes at low speed or valve to approximately half design flow. This will remove most of the air from the system high points. With the system pump turned off, open the vents and start the fill pump again. Repeat this procedure a few times, and when most of the air is eliminated, open the valves and run the system pump at full flow.

K. Use the system air separator to remove the final amounts of air. Once all the air is removed, run the fill pump again until the system expansion tank is at the proper level and the system is at the proper working pressure.

L. Keep circulating the heat transfer fluid through the system at the design pressure. Monitor the system pressure and make sure the pressure does not drop. If the pressure drops, there is a leak in the system.

M. Take a fluid sample, with the manufacturer supplied kit, after the system has been recirculating for 24 hours. Require the manufacturer to provide a thermal fluid water analysis report.

END OF SECTION 236513

N:\N0912.00\DOC\SPEC\2012_03-16_BID\236513 - GLYCOL HEAT TRANSFER FLUID.DOC

SECTION 236515 – CHEMICAL FREE HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division Specification Sections, apply to this section

1.2 BASIC MECHANICAL REQUIREMENTS

A. Basic Materials and Methods

B. Basic Piping Materials and Methods

C. Examine all drawings and data and coordinate the work of this Section with all related and adjoining work and trades

1.3 SUMMARY

A. This section includes water treatment systems for the following:
   1. Condenser Water - Open Cooling Water Loop Systems
   2. Closed Loop Systems

1.4 PERFORMANCE REQUIREMENTS

A. Maintain water quality for the Condenser water and closed systems that controls corrosion and build-up of scale and biological growth for a maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment. Maintain the following operational water quality parameters:
   1. Total Planktonic Bacteria Count (TBC) of less than 10,000 CFU/ml as determined by Heterotrophic Plate Count (HPC) under method SMEWW 9215B (1998) at 35degC for 48 hours using plate count agar (tryptone glucose yeast agar) per Section 9215A.6;
   2. Uniform mild steel corrosion of not more than 5 mils per year (mpy) as determined by minimum of 90 day corrosion coupon exposure;
   3. Uniform copper corrosion of not more than 0.35 mpy as determined by minimum of 90 day corrosion coupon exposure;
   4. No scale formation on immersed surfaces including Tower Basins, Tower Fill, Tower Sumps, Piping, Heat Exchanger Tubes;
   5. Water shall be odorless and clear in appearance with no turbidity;
   6. No surface slime layer formation on immersed surfaces as judged by touch;

B. Base performance requirements on quality of raw water available from the Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Use of chemical systems to achieve the condenser water quality parameters listed in PART 1.5 A will not be allowed. Use of mechanical systems for condenser water treatment requiring the aid or periodic use of chemicals such as biocides, scale inhibitors, and corrosion inhibitors will not be allowed. Methods of chemical introduction from solid components, such as copper or silver anode depletion, will not be allowed.

1.5 SUBMITTALS

A. Product Data: Include rated capacities; water pressure drops; shipping, operating and installed weights; and furnished products listed:
   1. Basis Of Design: Dolphin ™ Pulsed Power Chemical Free Water Treatment System by Clearwater Systems Corporation, Essex, CT
   2. Alternate Manufacturers: VRTX, Envirotower

B. Shop Drawings: Detailed equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection

C. Raw Water Analysis: Submit a copy of the project site water analysis to document the water quality available at the project site. Raw water test analysis to include at a minimum the analysis of the following compositions of the water:
   1. Calcium Hardness (as ppm CaCO3)
   2. Total Hardness (as ppm CaCO3)
   3. Total Alkalinity or m-Alkalinity (as ppm CaCO3)
   4. pH
   5. Silica (as SiO2)
   6. Specific Conductivity (μS/cm)
   7. Chloride (as Cl-)

D. Installation, Maintenance and Operation data for each piece of equipment, suitable for inclusion into a standard 3-ring binder.

1.6 QUALITY ASSURANCE

A. Manufacturer: Design, fabricate, and furnish an electronic pulsed power system manufactured to accurate dimensions, tolerances, and operating characteristics as specified in PART 2 – PRODUCTS of this specification section.

B. Supply equipment conforming to nationally recognized North American testing laboratory standards and bearing an “Approval Label” on all assemblies.

1.7 QUALIFICATIONS:

A. Manufacturer:
   1. Able to document a minimum of 5 years experience designing, manufacturing and supplying products for commercial, and industrial water treatment and water chemistry control.
   2. Maintain engineering and field service capabilities to ensure proper operation of the product within the service period specified in subsequent sections.
   3. All laboratory and technical service offices must be within 100 miles of jobsite to insure accurate HPC testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturers’ instructions. Store in original packaging.

B. Store in a dry location, protected from the elements, and from mud, dirt, and soiling

C. Protect components from damage during storage and handling.

D. Handle with care to prevent damage during movement and installation.

1.9 WARRANTY:

A. Comply with warranty provisions as specified in Section – Mechanical General Provisions

B. Provide special warranty for products specified in PART 2 – PRODUCTS of this specification Section

C. Standard Warranty - Manufacturer's standard form warranty of not less than one year from date of start-up covering replacement or repair of materials found to be defective in workmanship or quality.

PART 2 - PRODUCTS

2.1 GENERAL:

A. The contractor shall furnish and install an electronic pulsed power water treatment system as shown and detailed on the contract documents. The units shall be installed in accordance with this specification Section, and perform at the conditions as listed.

B. The unit must be a full flow device to maintain the biological counts required.

C. Approved manufacturers:
   1. Basis of Design: Clearwater Systems Corporation, Essex, CT
   2. Alternate manufacturers: VRTX, Envirotower

2.2 ELECTRONIC PULSE POWER CONDENSER WATER TREATMENT SYSTEM

A. Provide a complete pulse power water treatment system equal to the Dolphin System™ 3000 on:
   1. Condenser Water for Open Tower Systems (one 16" unit)

B. Condenser Water Treatment System Description
   1. The system shall consist of alternating current pulse power Transformer Panel and Coil-Pipe Assembly. Each Coil-Pipe assembly shall be equipped with a dedicated individual Transformer Panel.

C. Transformer Panel shall have/be:
   1. Wall mounted NEMA 3R metal enclosure, 304 brushed stainless steel case
   2. Terminal block for hard wiring to electrical power service.
   3. Fused primary on and secondary on 230v/1ph, 460v/1ph powered units (8" to 16" Dolphins)
   4. Dry form C contact (for building management system).
   5. Remote Start-Stop capability, switch field installed
   6. Female locking receptacle for connecting the Transformer Panel to the Coil-Pipe Assembly. Connection coded based on unit size to prevent mismatching of components
   7. LED Status indicating lights
   8. Powered Fan ventilation with inlet screen filter
   9. Pulsed power transformer and circuitry, which uses alternating current of 60 cycles per second to create a harmonic "ringing" signal of increasingly higher frequency until the decreasingly lower amplitude of this echo signal is damped down to zero. This effect imparts high frequency electric fields into the flowing water that includes frequencies in the kilohertz and megahertz range. Dolphin System 3000-G delivers a total of 240 pulses per second.
      a. Primary service:
         1) 8" thru 16": 208-230 VAC or 460 VAC, 60 cycle, 1 ph, primary service.
         2) 11 to 45 VAC secondary (depending on size).
         3) 150 to 2400 VA primary (depending on size).

D. Coil-Pipe Assembly:
   1. Pipe Material

a. 1" thru 16" - PVC Sch. 80 with flanged pipe ends

2. Field Connections:
   a. Furnish PVC Van Stone style (Slip-on) flanges for field mounting of Coil-Pipe Assembly
3. The coils shall be contained within a larger diameter PVC covering cylinder around the pipe and closed with PVC end caps with ventilation ports.
4. The high temperature coil bobbin assemblies are secured to pipe by circular clamps.
5. Locking power cable (Umbilical Cable) is supplied for connection between the Coil-Pipe Assembly and the Transformer Panel. Standard Umbilical cables are 10 ft. (Size 1" to 6") or 16 ft. (size 8" to 16").
   a. Furnish 25 ft. Umbilical Cable
6. Built in thermal protection shall automatically turn the coil assembly off if the operating temperature exceeds 200° F (PVC units 1" thru 6") or 190o F (PVC units 8" thru 16").
   a. The thermal protection for PVC units protects the internal circuitry from internally generated heat.
      1) The maximum applied fluid temperature of PVC units shall not exceed 140°F.

E. Pulsed power system (PPS) operational parameters:
1. Conductivity range of 300 to 5,000 µS/cm.
2. pH range of 6.8 to 9.0 or per cooling tower manufacturer's recommendation.
3. Local environmental regulations may dictate the highest pH permitted for blowdown. PPS can raise or lower pH by the balancing of fresh make-up water.
4. Total bacteria count (TBC) of less than 10,000 CFU/ml. The bacteria count is expected to range below 4,000 CFU/ml under most normal blowdown schedules.

F. System functions:
1. To keep system free from mineral scale on the fill material, pipes, heat exchangers, pipes, valves and other components in the system by changing calcium carbonate nucleation from surface nucleation to colloidal nucleation, thereby lowering activation energy of colloidal nucleation.
2. Control the population of microorganisms such as bacteria, algae and protozoa to 10,000 CFU/ml or below, by incorporation into colloidal precipitates (encapsulation) or through the pulsed power fields (electroporation) within the coil pipe assembly, regardless of what species are present and how they may have mutated.
3. Blowdown shall contain no added water treatment chemicals required to achieve performance listed. Neither oxidizing agents nor metals shall be added to the tower water.

G. Building Management System Interface
1. The interface to the building management system will be through a FORM "C" dry relay contact located on the circuit board in the transformer panel.
2. The interface will verify the following Dolphin operating status conditions
   a. Primary Power Status - e.g. Loss of utility power, tripped circuit breaker, blown fuse or unit unplugged.
   b. Secondary Power Status - e.g. Severed or removed coil assembly cable connection, defective transformer.
   c. Coil-Pipe Assembly Operation Status - e.g. Coil-Pipe Assembly overheated.
   d. Circuit Board Operation Status – e.g. Board overheated, electronic failure
   e. In the event of one of the above anomalies, the supervisory contact will change relay status.
      1) Supervisory Contact power rating
         a. 0.6 A at 125 VAC
         b. 0.6 A at 110 VDC
         c. 2.0 A at 30 VDC

H. Remote Start-Stop Switch

1. A remote switch shall turn off the coil-pipe Assembly, while maintaining power to the Transformer Panel. Switch shall be wired into predetermined contacts in the Transformer Panel.
    a. Status shall be indicated by a flashing green LED
    b. Utilize a field supplied 24v rated normally closed switch.

I. Initial System operation:
1. No water system containing a Dolphin System™ shall be put into operation without the Dolphin being energized and the blowdown system and mechanical filtration systems fully operational. Failure to comply may result in damage to connected heat exchange equipment from scaling and corrosion, or fouling from biological growth.
    a. New Tower Systems - The system shall initially be operated under blowdown settings or protocol specified by manufacturer. New galvanized towers must be conditioned to prevent white rust formation to the tower manufacturer's requirements. Operating the tower for a period of about 6 weeks with a pH below 8.3 accomplishes this conditioning. Alternately, chemical may be used to passivate galvanized towers prior to equipment start-up.

J. Conductivity Controller
1. Packaged Conductivity Meter/Controller: Provide a conductivity meter/controller with following functions:
    a. Provide NEMA 4x enclosure with lockable swinging door.
    b. Provide 115volt, single phase power plug cord.
    c. LCD display door setpoint and actual conductivity readout, solid state circuitry.
    d. High and low alarm with relay.
    e. 4 – 20 mA recorder output.
    f. Flow switch.
    g. LED indicators for power, control, alarm, no flow, and feed.

K. Blowdown Valve:
1. Provide Blowdown motorized ball valve equal to Belimo B2AF120, 115volt, single phase. Furnish cord with plug to connect to "Bleed" receptacle of the DC4000 conductivity controller. Furnish with watertight cover to maintain NEMA 3R if installed outdoors.
    a. Install same size valved bypass around blowdown valve for servicing and emergency manual blowdown operation.
    b. Do not install strainer(s) in blowdown line.
    c. Install throttling ball valve downstream of the blowdown valve to make adjustments in blowdown volume rate if required.

L. Corrosion Test Coupon Assembly:
1. Constructed of PVC, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test coupon assembly. Include isolation and ball valves and a visual water flow balancing device. Entire assembly shall be mounted on a polyethylene panel suitable for wall mounting.
    a. Two-station rack equal to ACR-20BE.

2.3 CLOSED LOOP SYSTEM TREATMENT

A. General
1. Contractor will furnish and install all equipment, chemicals and service necessary to provide a complete Water Treatment Program. A single water treatment company shall provide all products and services for undivided responsibility throughout the warranty period. The water treatment company shall have a regional accredited laboratory, research and development facilities, plus technical service representatives located within the trading area of the job site.

B. Chemical Feeding Equipment (Hot / Chilled water) Closed Loop
   1. For each closed system the contractor shall provide and install the following apparatus (including isolation and drain valves):
      a. One shot feeder, minimum five gallon capacity with quarter turn cap and 3-½" opening. The feeder shall be rated for 200 psi service.

C. Water Treatment Chemicals
   1. Furnish one year's supply of the recommended formulas for control of scale and corrosion in the closed recirculating system. Formulations shall not contain any ingredients which may be harmful to system materials of construction. Provide MSD sheets on all chemical products. No system shall be operated without the benefit of chemical protection. Once the recommended chemical residual is achieved, any additional chemicals required to re-treat the system due to water loss or to accomplish other work shall be provided by the Mechanical Contractor. Products shall be Nitrite based.

D. Test Equipment
   1. Furnish basic water test equipment, including carrying case and spare reagents for maintaining control of the program standards in the closed loop system. Test kit will include reagents and apparatus for the determination of corrosion inhibitor level in the closed loop system.

E. Water Treatment Service Program
   1. The water treatment company shall provide all consulting services for a period of one year from start-up of the Closed Loop system which will include:
      a. Installation and system start-up procedure recommendations.
      b. Initial water analysis and recommendations.
      c. Training and operating personnel on proper feeding and control techniques.
      d. Monthly field service and consultation meetings.
      e. Any necessary log sheets and record forms.
      f. Any required laboratory and technical assistance.
   2. All services will be provided by a qualified, full-time representative of the water treatment supplier.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field conditions and suitability for installation according to manufacturer's published installation data.

3.2 INSTALLATION

A. Install equipment level and plumb. Locate panels with indicator lights at eye level.

B. Install equipment per manufacturer's recommendations.
   1. Locate system components according to manufacturer's recommendation.
      a. Locate coil-pipe assembly in piping no closer than 3 ft from sources of turbulence such as the pump outlet. Consult manufacturer should field conditions fail to meet such clearances.
      b. Transformer panel and coil-pipe assembly should be located at least 3 ft. from additional units and 3 ft. from any large motor, pump, or high voltage equipment or source which may influence the system high frequency electric fields.
   2. Coil-pipe assembly should be supported by pipe hangers located no closer than 2" to the outer cover. Do not support or secure the coil-pipe assembly by means of the outer cover. Do not install bands, hangers, wires, hooks around the outer cover.

3. Coil-Pipe Assembly should not be energized for extended periods of time without having the pipe full of water. If the flow in the pipe will drain when the pumps are off, then the unit must be de-energized under these no flow conditions.
4. Loosely loop excess length of the coil-pipe assembly umbilical cord. Do not coil tightly.
5. Both the transformer panel and coil-pipe assembly should be installed at least 3 ft. from any motor, pump or high voltage equipment which might influence the system high frequency electromagnetic field.

C. Cleaning of piping systems containing the Chemical free system.
1. Immediately after hydrostatic testing of piping is completed, systems shall be cleaned, drained, and flushed with clean water. Any chemical additives used in this process shall be thoroughly flushed from the piping system.
2. If the system is not immediately put into operation after cleaning and flushing, the system shall be drained of any stagnant water left over from testing or flushing. Immediately prior to putting the system™ into operation, the system shall be re-filled with clean water.
3. Consult manufacturer representative for additional details.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Size and install the control loop piping to conductivity and optional sensors and/or corrosion coupon racks in the size PVC to match fittings provided. Install field provided full port ball valves for isolation of sensors and racks for routine maintenance. Control loop sensors shall not be installed directly in the piping mains.

D. Control loop shall be piped from the pressure side of the recirculating pump to the suction side of the pump, so that the control loop senses the highest temperature of the fluid system. In the case of Fluid Coolers or Evaporative Condensers, the control loop shall be taken from the pump discharge and the water shall be returned to the sump.

E. Blowdown line should not be attached to the control loop. Install the blowdown line on the pressure side of the recirculating pump, preferably from the bottom of the pipe to relieve the system of accumulated solids, dirt, and debris.

F. Confirm applicable electrical requirements in Division 16 Sections for connecting electrical equipment. Power and control and interlock wiring materials and labor provided by Division 16
1. Provide proper electrical ground top the equipment.
2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. No water system shall be put into operation without the unit being energized and the blowdown system and mechanical filtration systems fully operational. Failure to comply may result in damage to connected heat exchange equipment from scaling and corrosion, or fouling from biological growth.

B. Engage a factory-authorized service representative to perform startup service.
1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.

C. Initial Start-up Service – At no additional cost to the owner, a manufacturer representative shall set up the blow-down system according to the submitted operational parameters as indicated by the site water analysis as specified in PART 1.6 D – Submittal Data of this Section. An Initial Start-up Service report shall be provided to the operator and to Clearwater Systems.

3.5 ADJUSTING

A. Start-up and First Year Monitoring Service:
1. Initial Start-up Service:
a. At no additional cost to the owner, approximately every 30 days for 90 days from Initial Start-up Service, a manufacturer representative shall monitor the performance of the system.
b. A written Service Report shall be provided to the owner/operator and to manufacturer systems. The monitoring by the manufacturer representative will include the following:
1) Inspection of the system for functionality
2) Inspection of the blowdown system for functionality
3) Calibration and cleaning of conductivity probes or other instrumentation related to blow down
4) Visual inspection of overall system condition as accessible. Service visits may be timed to coincide with the opening of certain system components such as a closed vessel or chiller.
5) At each service visit, a field analysis of the following water chemistry parameters will be performed using field test kits.
a. pH
b. Specific Conductivity (µS/cm)
c. HPC by dipslide. Culture per package insert instructions.
c. Within 30 days and 90 Days after Start-up, but after tower conditioning is completed, a water sample shall be taken and the following parameters shall be evaluated by utilizing an independent and certified commercial laboratory:
1) Total Bacteria Count, planktonic (by HPC)
2) pH
3) Specific Conductivity (µS/cm)
4) Chloride (as Cl-)
5) Total Hardness (as ppm CaCO3)
6) Total Alkalinity or m-Alkalinity (as ppm CaCO3)
7) Calcium Hardness (as ppm CaCO3)
8) Depending upon raw water analysis, other tower water chemistry my be desired
a. Magnesium Hardness (as ppm CaCO3)
b. Silica (as SiO2)
c. Sulfate (as SO4)
d. Phosphate (as PO4)
2. First Year Service and Reporting:
a. For the first 9 months after the Initial 90 Day Monitoring, at no additional costs to the owner, perform monthly service and monitoring visits.
1) A written Service Report shall be provided to the owner/operator and to manufacturer. The monitoring by the manufacturer representative will include the following:
a. Inspection of the Dolphin System™ for functionality
b. Inspection of the blowdown system for functionality

c. Calibration and cleaning of conductivity probes or other instrumentation related to blow down

d. Visual inspection of overall system condition as accessible. Service visits may be timed to coincide with the opening of certain system components such as a closed vessel or chiller.

e. At each service visit, a field analysis of the following water chemistry parameters will be performed using field test kits.

(1) pH

(2) Specific Conductivity (µS/cm)

(3) HPC by dip slide. Culture per package insert.

b. For the first 9 months after the Initial 90 Day Monitoring, at no additional costs to the owner, perform two (2) water analyses of the water chemistry parameters in Part- 3.5 Section A.1.c to ensure that the system is maintaining water quality within performance requirements specified in this Section.

1) Perform analyses at least 60 days apart. Submit written reports of water analysis using field test kits to the operator and to manufacturer. Monitor and report as described in Part- 3.5 A.1.b. above.

c. Make adjustments to the conductivity controller and blow-down system as required to maintain water quality after each visit.

3. Provide adjustments to the blow-down and conductivity settings as required during and after the initial 6 week conditioning of new galvanized towers.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

1. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 Section "Closeout Procedures."

2. Schedule at least four (4) hours of training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 236515

N:\N0912.00\DOC\SPEC\2012_03-16_BID\236515 - CHEMICAL FREE HVAC WATER TREATMENTS.DOC

SECTION 237250 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.

B. The drive manufacturer shall supply the drive and all necessary options as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

C. VFD's specified in this section apply to VFD's for air handling units, exhaust and return fans, cooling towers and pumps. Chiller manufacturers shall provide VFD's designed for the specific chiller duty, performance and efficiency.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers (IEEE)
      a. Standard 519-1992, IEEE Guide for Harmonic Content and Control.
   2. Underwriters laboratories
      a. UL508C
   3. National Electrical Manufacturer's Association (NEMA)
      a. ICS 7.0, AC Adjustable Speed Drives
   4. IEC 16800 Parts 1 and 2
   5. National Electric Code (NEC)
      a. NEC 430.120, Adjustable-Speed Drive Systems
   6. International Building Code (IBC)

B. Qualifications:
   1. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs with red label UL stickers, requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
   2. CE Mark – The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
   3. Acceptable Manufacturer:
      a. ABB ACH550 Series.
   4. The VFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering VFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's

site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID number. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.

1.3 SUBMITTALS

A. Submittals shall include the following information:
   1. Outline dimensions, conduit entry locations and weight.
   2. Customer connection and power wiring diagrams.
   3. Complete technical product description include a complete list of options provided. Any portions of this specification not meet must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification.
   4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
      a. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, no exceptions.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. Manufacturers: Provide products subject to compliance with specification, by one of the following:
   1. ABB-ACH 550.

B. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
   1. Environmental operating conditions: VFDs shall be capable of continuous operation at 0 to 50^0 C (32 to 122^0 F) ambient temperature as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFD's that can only operate at 40° C intermittently (average during a 24 hour period) and therefore must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
   2. Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable. NEMA only type 1 enclosures are not acceptable (must be UL Type 1).

C. All VFDs shall have the following standard features:
   1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote

mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.
6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
9. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add an AC line reactor.
10. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.
11. The VFD shall include a coordinated AC transient surge protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
12. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.
13. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload

14. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.
15. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.
16. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

D. All VFDs to have the following adjustments:
1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.
2. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.
3. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
4. Two (2) programmable analog inputs shall accept current or voltage signals.
5. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
6. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC or 24VAC.
7. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.
8. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety input status shall also be transmitted over the serial communications bus.

9. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 – 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass.
10. Seven (7) programmable preset speeds.
11. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
12. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
13. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
14. The VFD shall include password protection against parameter changes.

E. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:
1. Start-up assistant
2. Parameter assistants
   a. PID assistant
   b. Reference assistant
   c. I/O assistant
   d. Serial communications assistant
   e. Option module assistant
   f. Panel display assistant
   g. Low noise set-up assistant
3. Maintenance assistant
4. Troubleshooting assistant
5. Drive optimizer assistants

F. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency
2. Motor Speed (RPM, %, or Engineering units)
3. Motor Current
4. Motor Torque
5. Motor Power (kW)
6. DC Bus Voltage
7. Output Voltage

G. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined

safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.

H. Serial Communications

1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. Optional protocols for BACnet IP, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.
2. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
   a. Data Sharing – Read Property – B.
   b. Data Sharing – Write Property – B.
   c. Device Management – Dynamic Device Binding (Who-Is; I-Am).
   d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
   e. Device Management – Communication Control – B.
3. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.
4. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
5. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
6. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function. The analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive and bypass' digital (Form-C relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive and bypass' digital inputs shall be capable of being monitored by the DDC system. This allows for remote monitoring of which (of up to 4) safeties are open.
7. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value / hot water valve control, etc. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As

default, the VFD shall keep the last good set point command and last good DO & AO commands in memory in the event the serial communications connection is lost and continue controlling the process.

I. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.

J. All VFD's through 75HP at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.

K. OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
   1. Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options. Circuit breaker option shall be available with or without systems requiring bypass.
   2. Fieldbus adapters - Optional protocols such as LonWorks, DeviceNet, Ethernet IP (ControlNet over Ethernet & ModBus TCP), BACnet IP, and Profibus shall be available with the addition of an option card.

L. BYPASS CONTROLLER
   1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses are required. UL Listed motor overload protection shall be provided in both drive and bypass modes.
      a. By-pass controller are not required chilled, condenser, glycol and heating water pumps in the main mechanical room. Door interlocked line input and output disconnects shall be provided for these pumps for servicing of VFD.
   2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
   3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.
   4. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the bypass, will not be accepted.
   5. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
   6. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
   7. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor

in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.

8. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.
9. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet.
10. Serial communication capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and / or via a Form-C relay output – keypad "Hand" or "Auto" selected, bypass selected, and broken belt indication. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.
11. The bypass serial communications shall allow control of the bypass' digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass' digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the bypass' digital inputs shall be capable of being monitored by the DDC system.
12. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause only a warning or a fault and / or system shutdown.
13. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.
14. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open (motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman's override / smoke control mode.
15. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to fire a Form-C relay output, and / or over the serial communications protocol.
16. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open

before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

17. There shall be a keypad adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:
    a. Over current
    b. Over voltage
    c. Under voltage
    d. Loss of analog input
18. The following operators shall be provided:
    a. Bypass Hand-Off-Auto
    b. Drive mode selector
    c. Bypass mode selector
    d. Bypass fault reset
19. The bypass shall include a two line, 20 character LCD display. The display shall allow the user to access and view:
    a. Energy savings – in US dollars
    b. Bypass motor amps
    c. Bypass input voltage– average and individual phase voltage
    d. Bypass power (kW)
    e. Bypass faults and fault logs
    f. Bypass warnings
    g. Bypass operating time (resettable)
    h. Bypass energy (kilowatt hours – resettable)
    i. I/O status
    j. Parameter settings / programming
    k. Printed circuit board temperature
20. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
    a. Power-on (Ready)
    b. Run enable
    c. Drive mode selected
    d. Bypass mode selected
    e. Drive running
    f. Bypass running
    g. Drive fault
    h. Bypass fault
    i. Bypass H-O-A mode
    j. Automatic transfer to bypass selected
    k. Safety open
    l. Damper opening
    m. Damper end-switch made
21. The Bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs. This I/O allows for a total System (VFD and Bypass) I/O count of 24 points as standard. The bypass I/O shall be available to the BAS / DDC system even with the VFD removed.
22. The on-board Form-C relay outputs in the bypass shall programmable for any of the following indications.
    a. System started
    b. System running
    c. Bypass override enabled
    d. Drive fault

e. Bypass fault
f. Bypass H-O-A position
g. Motor proof-of-flow (broken belt)
h. Overload
i. Bypass selected
j. Bypass run
k. System started (damper opening)
l. Bypass alarm
m. Over temperature

23. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
24. The bypass shall include a supervisory control mode. In this bypass mode, the bypass shall monitor the value of the VFD's analog input (feedback). This feedback value is used to control the bypass contactor on and off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps even with the VFD out of service.
25. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include "FireStat", "FreezStat", "Over pressure" and "Low suction". The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.
26. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User's Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties as required by UL 864/UUKL. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
27. Fireman's Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for "Run-to-Destruction". The user may also force the unit into Override 2 via the serial communications link.
28. Class 10, 20, or 30 (programmable) electronic motor overload protection shall be included.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.

B. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current. Caution: VFDs supplied without internal reactors

have substantially higher input current ratings, which may require larger input power wiring and branch circuit protection. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.2 START-UP

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.3 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.

B. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.4 WARRANTY

A. The VFD Product Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. A toll free 24/365 technical support line shall be available.

END OF SECTION 237250

SECTION 237313 - INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide factory-fabricated custom air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit in the space available with adequate clearance for service as determined by the Engineer. All units shall come completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor.
   1. Factory representative shall instruct contractor in the proper re-assembly of unit and shall field inspect assembled units. Factory representative shall furnish certification that units have been inspected and that assembled units meet the manufacturers quality standards.

B. Section Includes:
   1. Factory custom, variable-air-volume, single-zone air-handling units with multiple direct drive supply fan wall panel, enthalpy wheels, variable frequency drives and air flow measuring stations as indicated on plans.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

1.4 SUBMITTALS

A. Product Data: For each air-handling unit indicated.
   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Dampers, including housings, linkages, and operators.
   6. Filters with performance characteristics.
   7. Variable frequency drives.

8. Wiring diagrams.
9. Factory furnished air flow measuring stations.

B. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: Two set(s) for each air-handling unit for each pre-filter, gas phase and final filters.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: Two set(s) for each belt driven air-handling unit fan.
4. Fan/Motor Assembly: One spare fan/motor for each air handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
   1. Ingenia
   2. Governair
   3. Energy Labs

2.2 UNIT CASINGS

A. Unit Base / Frame / Floor:
   1. Provide a full perimeter welded base frame manufactured with structural steel tubing and C-Channel cross support members on close centers. Unit frame shall be from 14-gauge carbon tubular steel, mig welded to form a unitized assembly for support of all internal components. Base and unit frame shall be painted with a lacquer resisting gray phenolic corrosion inhibitive primer. Base rails shall be fitted with lifting lugs at the corner of the unit or section (if de-mounted). The base shall include a 3-inch thick insulated “double bottom” floor with minimum 20 gauge G-90 galvanized outer and 16 gauge G-90 galvanized inner walk in surface. All floor seams shall be gasketed, caulked and sealed for an airtight / thermal break floor. Base frame shall be attached to the unit at the factory.

B. Exterior Panels:
   1. The exterior panel shall be fabricated from formed 16 gauge G-90 galvanized steel with exterior coating as specified below. Flat panel design is not acceptable. The air handling unit casing shall be of the “no-through-metal” design. The casing structure shall incorporate insulating thermal breaks as required so that, when fully assembled, there exist no path of continuous unbroken metal to metal conduction from inner to outer surfaces. Provide necessary support to limit casing deflection to 1/200 of the narrowest panel dimension. If panels cannot meet this deflection, add additional internal reinforcing. Panels shall be gasketed and secured to the tubular steel frame with 1/4" hex head, zinc plated fasteners and neoprene washers. Outer panels must be removable without affecting the structural integrity of the unit. All panel seams shall be caulked and sealed for an airtight unit. Leakage rates shall be less than 1% at design static pressure or 8” whichever is greater. The exterior panel finish shall be non paint: Bright spangled galvanized. The color shall be sterling gray.

C. Double Wall Construction:
   1. Each unit shall have double wall construction with 16 gauge solid galvanized steel liner in the entire unit. The entire double wall panel shall be removable from the outside of the unit without affecting the structural integrity of the unit.

D. Insulation:
   1. Entire unit section shall be insulated with full 2-inch thick non-compressed fiberglass insulation. The insulation shall have an effective thermal conductivity (C) of 0.24 (BTU in./sq.ft./Fº) and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). The coefficients shall meet or exceed a 3.0 P.C.F. density material rating. Insulation shall meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88). All insulation edges shall be encapsulated within the panel.

E. Inspection and Access Panels:
   1. Panel Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
   2. Inspection and Access Panels:
      a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
      b. Gasket: Bulb-type, neoprene, applied around entire perimeters of panel frames.
      c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
   3. Access Doors:
      a. Door Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
      b. The doorframe shall be extruded aluminum with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be die cast zinc with stainless steel pivot mechanism, completely adjustable. There shall be a minimum of two heavy duty Ventlok 360 handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
      c. Gasket: Neoprene, bulb-type, applied around entire perimeters of panel frames.
      d. Fabricate windows in doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
   4. Locations and Applications:
      a. Fan Section: Doors.
      b. Access Section: Doors.
      c. Coil Section: Inspection and access panel.
      d. Damper Section: Doors.
      e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
      f. Mixing Section: Doors.
      g. Enthalpy Wheel Section: Doors.
      h. Discharge Plenum: Doors.
   5. Service Light: 100 watt fluorescent, vapor proof fixture wired to a single timer switch box located outside of supply fan section access door.
      a. Locations: Each section accessed with door.

F. Condensate Drain Pans:
   1. IAQ style drain pans fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from heating coils and to direct water toward drain connection. The drain pan shall be fabricated from 16 gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4” MPT drain connection extended to the exterior of the unit base rail. Units in excess of 159 inches shall have drain connections on both sides. All drain connections shall be piped and trapped separately for proper drainage. .
      a. Depth: A minimum of 2 inches deep.
   2. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
   1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Fan Wall Panel: The fan wall shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified, (Class I, or II). All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan wall array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. The array shall be provided with acoustical Coplanar silencers that reduce the bare fan discharge sound power levels throughout the eight octave bands.
1. All motors shall be standard pedestal mounted type TEFC T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. All motors shall include shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance at design RPM. This balance equates to a vibration velocity less than or equal to 0.080 in. per second. Vibration amplitudes are in inches per second – peak. All values are filter-in at the fan speed. All other balance by others in field.
2. The fan array shall consist of multiple fans and motors, spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. Each fan motor shall be individually wired to a control panel containing a minimum of two VFDs, as specified elsewhere, for the total connected HP for all fan motors contained in the fan wall array. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards.
3. The manufacturer shall provide a complete spare fan/motor assembly for emergency replacement, one for each type of assembly provided on the project.
4. Each supply fan shall be provided with an automatic back draft designed for "zero systems effect".
5. Fan inlet cones shall be furnished with Ebtron extended face inlet cone air flow measuring stations wired to a single air flow measuring panel.

C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

D. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 2 inches.

E. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.4 COIL SECTION

A. General Requirements for Coil Section:
1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

4. Stainless steel drain pan under heating coil with capped drain to the outside.

2.5 FILTER SECTION

A. Filters modules shall have filter racks, at one access door for filter removal, and filter block-offs to prevent air bypass around filters. The modules shall be supplied with 2-inch flat, anol cartridge, filters.

B. Filters: Comply with NFPA 90A.

C. Pleated Media Pre-filters: The filters shall be 2-inch thick, nonwoven fabric, treated with adhesive and continuously laminated to a supported steel-wire grid. Filters shall be capable of operating up to 625-fpm face velocity without loss of filter efficiency and holding capacity. The filters shall have a rated average dust-spot efficiency of 35-percent (MERV 7 rating) when tested in accordance with the ASHRAE Standard 52.2 atmospheric-dust-spot method.

D. Cartridge Final Filters: The filters shall be constructed with a continuous sheet of fine-fiber media made into closely spaced pleats with safe-edge aluminum separators. The filters shall be capable of operating up to 625-fpm face velocity for 12-inch-deep filters without loss of filter efficiency and holding capacity. The filters shall be sealed into a metal frame assembled in a rigid manner. The gasket material shall be installed on the metal header of the filter to prevent filter bypass where the metal headers meet on the side-access racks. The manufacturer shall supply a side-access filter rack capable of holding cartridge filters and prefilters. Cartridge filters shall have a 90-95-percent dust-spot efficiency (MERV 14 rating) based in ASHRAE Standard 52.2.

E. Filter Gage:
1. 3-1/2-inch- diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 2.0-inch wg.
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.6 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

C. Electronic Damper Operators:
1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC."
b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
   e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24-V ac.
11. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.
14. Run Time: 90 seconds.

D. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in parallel-blade arrangement with cadmium-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single extruded-aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

E. Airflow Monitoring Station: The air monitoring station shall combine the functions of control damper and flow measurement station in one assembly. Air straightener shall be 3000 series aluminum alloy honeycomb contained in 5" long 16 gage galvanized sleeve attached to monitoring blade frame.. Fixed anodized aluminum monitoring blades are mounted in 10" 16 gage galvanized frame. Control dampers feature airfoil shaped 6063T5 heavy gage extruded aluminum blades rotating on 1/2" plated steel hex axles, mounted in a 4"x 1" 6063T5, .081" thickness extruded aluminum channel with mounting flanges on both sides of frame. Jamb seals are flexible metal compression type. Neoprene blade seals along control damper blade edges. Bearings shall be molded synthetic. Linkage is galvanized steel, concealed in frame. The acceptable range of operation is 200- fpm to 2000- fpm face velocity. The air monitoring station shall be tested to AMCA Standard 611-95 and qualified to bear the AMCA Ratings Air flow measuring station and damper shall be Ebtron-Tamco (Gold)

F. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

G. Combination Filter and Mixing Section:

1. Cabinet support members shall hold 2-inch- thick, pleated, flat, permanent or throwaway filters.
2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

H. Variable Frequency Drives: Provide a minimum of two factory mounted and wired variable frequency drives (VFD) for each unit. Refer to Section 237250 – Variable Frequency Drives. Each drive shall be wired to control 100% of the multiple fan arrangement. Second VFD shall be wired as full stand-by with manual switchover. Each drive shall be furnished with disconnects in line input side and for each motor on the output side to allow service of a fan motor while other fans are energized.
1. Current sensors shall be factory installed at each VFD output to fan motors. Current sensors shall be wired to a junction box mounted near the VFD's for field connection by the BAS Contractor.

2.7 ENTHALPY HEAT WHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advanced Thermal Technologies.
2. Airxchange Inc.
3. American Energy Exchange, Inc.
4. SEMCO Incorporated.

B. Casing:
1. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
2. Casing seals on periphery of rotor and on duct divider and purge section.
3. Support vertical rotors on grease-lubricated ball bearings having permanently lubricated bearings. Support horizontal rotors on tapered roller bearing.

C. Rotor: Aluminum segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.
1. Maximum Solid Size for Media to Pass: 500 micrometer.

D. Rotor: Polymer or aluminum segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
1. Maximum Solid Size for Media to Pass: 800 micrometer.

E. Drive: Fractional horsepower motor, with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Controls:
1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
3. Variable frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
4. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust

temperature above freezing and air differential temperature above set point. Rotor speed shall increase to maximum when exhaust-air temperature is less than outdoor-air temperature.

5. Pilot-Light Indicator: Display rotor rotation and speed.
6. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
7. BACNet or LONTalk communication capable to allow start/stop control thru the AHU DDC controls and monitoring of status and temperature.

2.8 CAPACITIES AND CHARACTERISTICS

A. As scheduled on plans.

2.9 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

1. Install galvanized-steel plate to equally distribute weight over pad.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Test operation of enthalpy wheel.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Verify that proper thermal-overload protection is installed for electric coils.
9. Install new, clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.
4. Test air flow measuring stations.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

END OF SECTION 237313

N:\N0912.00\DOC\SPEC\2012_03-16_BID\237313 - INDOOR CENTRAL STATION AIR HANDLING UNITS.DOC

SECTION 238126 – VARIABLE FLOW REFRIGERANT AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes split-system air-conditioning units consisting of variable capacity, heat recovery air conditioning system with variable refrigerant volume (heat and cool model) split system. The system shall consist of multiple evaporators, branch selector boxes, factory approved joints and header connection methods, a two or three pipe refrigeration distribution system using PID control and variable flow refrigerant condenser unit.

B. The condenser shall be a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant. The condensing unit may connect an indoor evaporator capacity up to 200% of the condensing unit capacity.

C. All zones shall be capable of operating separately with individual temperature control. A dedicated hot gas pipe shall be required to ensure optimum heating operation performance.

D. The indoor units shall be connected to the condensing unit utilizing manufacturers specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable.

E. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface with ASHRAE Standard 135 BACNet Open Protocol.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram of refrigerant piping, power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.

D. The system shall be installed by a factory trained contractor. Installing contractor shall submit training certification proof with shop drawings. The mechanical contractor shall have complete knowledge of the HVAC system operating and installation requirements.

E. Field piping shall be installed by a licensed refrigeration technician and shall comply with relevant local and nation regulations.

1.5 COORDINATION

A. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years (parts and labor) for compressors from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:
   1. Mitsubishi Electronics America, Inc.; HVAC Division.

2.2 INDOOR, CONCEALED OR EXPOSED EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

1. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2004.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: Variable or multispeed, Direct drive, centrifugal fan.

D. Fan Motors: Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."
1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

E. Filters: Disposable, with ASHRAE 52.2 MERV rating of 6 or higher.

2.3 AIR-COOLED, INVERTER CONTROLLED COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
1. Compressor Type: Scroll.
2. Inverter controlled compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
3. Refrigerant: R-407C or R-410A, variable flow control.
4. Reversing valves and controls for heat pump duty units.
5. Electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
6. The system shall automatically restart operation after a power failure and shall not cause any settings to be lost to eliminate reprogramming.
7. The unit shall incorporate an auto-charging feature.
8. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
9. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
10. Each system shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
11. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
12. Condensing unit fan shall consist of one or more propeller type, direct-drive 350 or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
13. Scroll compressors shall be variable speed, inverter controlled capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
14. Samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
15. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll with a maximum speed of 7,980 rpm.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.

D. Fan: Aluminum-propeller type, directly connected to motor.

E. Motor: Permanently lubricated, with integral thermal-overload protection.

F. Low Ambient Kit: Permits operation cooling operation down to -4 deg F and heating operation down to -0 deg F.

G. Mounting Base: Polyethylene.

H. Snow guard.

I. Master Controller with BACNet Open Protocol.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 15 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

B. Thermostat: Low voltage with sub-base to control compressor and evaporator fan.

C. Thermostat: Wall mounted, hard wired to control compressor and evaporator fan, with the following features:
1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. 24-hour/7-day programmable.
4. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
5. Fan-speed selection, including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Piping: System shall be capable of refrigerant piping up to 540 actual feet or 620 equivalent feet from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280 feet of piping between the condensing and indoor units with 295 feet maximum vertical difference, without any oil traps.

F. Manufacturers specified piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

G. Retain subparagraph below if applying for LEED certification. LEED-NC Prerequisite EA 2 requires minimum pipe insulation thickness equal to requirements in ASHRAE/IESNA 90.1-2004, "Minimum Pipe Insulation Thickness." Requirements for minimum insulation thickness vary by pipe size and temperature.
1. Minimum Insulation Thickness: 1 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install compressor-condenser components on neoprene pads with a minimum static deflection of ¼ inch. Refer to Division 15 Section "Vibration Controls for HVAC Piping and Equipment."

D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 16 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.2 REFRIGERANT PIPING

A. Do not use flux when brazing the refrigerant piping. Use the phosphor copper brazing filler metal (B-Cu93P-710/795: ISO 3677) which does not require flux. (Flux has an extremely negative effect on refrigerant piping systems. For instance, if the chlorine based flux is used, it will cause pipe corrosion or, in particular, if the flux contains fluorine, it will damage the refrigerant oil.)

B. Pipes shall be clean inside and outside and shall not accumulate harmful sulfur, oxidants, dirt, moisture, or other contamination. (Foreign materials inside pipes including oils for fabrication must be 0.14 gr/10 ft or less.)

C. Use the following items for the refrigerant piping:
   1. Material: Jointless phosphor-deoxidized copper pipe
   2. Size: Refer to manufacturers' literature to determine the correct size.
   3. Thickness: Select a thickness for the refrigerant piping that complies with national and local laws.

D. For piping work, follow the maximum tolerated length, difference in height, and length after a branch per the manufacturer's recommendation.

E. Provide outdoor unit multi connection piping kit and refrigerant branching kit for connection of piping between outdoor units and piping branches.

F. Use only items specifically selected for the outdoor unit multi connection piping kit and refrigerant branching kit selection per manufacturer's recommendations.

G. Protect the piping to prevent moisture, dirt, dust, etc. from entering the piping by pinching the pipe if left for a month and taped if less than a month.

H. Exercise special caution to prevent dirt or dust when passing piping through holes in walls and when passing pipes edges to the exterior.

I. Perform nitrogen permutation or nitrogen blow when brazing. Brazing without performing nitrogen permutation or nitrogen blow into the piping will create large quantities of oxidized film on the inside of the pipes, adversely affecting valves and compressors in the refrigeration system and preventing normal operation.

J. The pressure regulator for the nitrogen released when brazing shall be set to approximately 2.9 psi (Enough to feel a slight breeze on your cheek).
   1. Do not use anti-oxidants when brazing the pipe joints. Residue can clog pipes and break equipment.

K. Removing pinch piping after removing gas when connecting refrigerant piping to an outdoor unit, remove the pinch piping per manufacturer's recommendation. Any gas remaining inside may blow off the pinch piping when you dissolve the brazing, causing damage.

L. Consult manufacturer when connecting refrigerant piping to outdoor units.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238126

N:\N0912.00\DOC\SPEC\2012_03-16_BID\238126 - VARIABLE FLOW REFRIGERANT AIR-CONDITIONERS_FL.DOC

SECTION 238216 - AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of air coils that are not an integral part of air-handling units:
   1. Hot-water.

B. Related Sections include the following:

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.

B. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 WATER COILS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Trane or a comparable product by one of the following:
   1. Carrier Corporation.
   2. Dunham-Bush, Inc.
   3. USA Coil & Air.

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.

F. Fins: Aluminum, minimum 0.010 inch thick.

G. Headers: Cast iron with cleaning plugs, and drain and air vent tappings or seamless copper tube with brazed joints, prime coated.

H. Frames: Galvanized-steel channel frame, minimum 16-gauge thick for flanged mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Straighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 15 Section "HVAC Instrumentation and Controls," and other piping specialties are specified in Division 15 Section "Hydronic Piping."

END OF SECTION 238216

N:\N0912.00\DOC\SPEC\2012_03-16_BID\238216 - AIR COILS.DOC

SECTION 238233 - CONVECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Hydronic baseboard radiators.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Details of custom-fabricated enclosures indicating dimensions.
   3. Location and size of each field connection.
   4. Location and arrangement of piping valves and specialties.
   5. Location and arrangement of integral controls.
   6. Enclosure joints and other accessories.
   7. Method of attaching convection units to building structure.

C. Color Samples for Initial Selection: For units with factory-applied color finishes.

D. Color Samples for Verification: For each type of exposed finish required.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For convection heating units to include in emergency, operation, and maintenance manuals.

G. Warranty: All radiators are covered by a 5-Year Limited Warranty.

PART 2 - PRODUCTS

2.1 HOT-WATER BASEBOARD RADIATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Runtal North America, Inc.

B. General:
   1. Provide steel double panel radiators of the lengths and in locations as indicated, and of capacities, style and having accessories as scheduled.

C. Construction: The double heating panel radiation shall be of one-piece all-welded steel construction, consisting of a pair of flattened water tube panels welded to headers at each end. Welded to the inside of each panel shall be steel corrugated fins to increase the convective output of the radiator. The fins shall start at no less than 3" from the end of the radiator. The radiators shall include an integral heavy gauge (0.09" minimum) all-welded perforated top grille, which will cover the top of all of the finned areas.
The headers shall include all necessary inlet, outlet and vent connections as required. Internal baffling shall be provided where required for proper water flow. The radiant heating panels shall be available in lengths from 2'-0" to 29'-6" in two inch even increments without the need for splicing.

D. Pressure Ratings: Pressure ratings for the radiation shall be as follows.
1. Working Pressure 56 psig.
2. Test Pressure 74 psig.
3. Number of Tubes High: Two.
4. Number of Tubes Deep: Two.
5. Fin Spacing: No less than 32 fins per foot.
6. Panel radiation expansion shall not exceed 1/64" per foot of radiation at 215ºF. The installer shall provide adequate expansion compensation for each radiator.

E. Mounting:
1. Vestibules: The panel radiation shall be mounted to typical stud wall construction without additional blocking or strapping. Appropriate wall mounting brackets shall be provided with the radiation.
2. Second Floor Entry Lobby: Factory curved radiators installed along window mullions with radius matching wall curvature. The radiators are to be provided with floor mounted pedestals.

F. Finish: The panel radiation shall be cleaned and phosphatized in preparation for the powder coat finish. The radiation shall be then finish painted with a gloss powder coat finish, for a total paint thickness of 2-3 mils (0.002" - 0.003"). The color shall be selected form the standard colors by Architect.

G. Accessories:
1. Steel piping covers finished to match radiator finish.
2. Flex connectors shall be used where appropriate to provide expansion compensation for the radiators.
3. Full trim covers to conceal side piping on both sides of radiator.
4. Integral temperature sensor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before convection heating unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BASEBOARD RADIATOR INSTALLATION

A. Install units level and plumb.

B. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

C. Install piping within pedestals for freestanding units.

D. Install expansion compensation hoses.

E. Install piping covers.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 15 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water units and components to piping according to Division 15 Section "Hydronic Piping."
   1. Install shutoff valves on inlet and outlet, Y-strainer on inlet and balancing valve and control valve on outlet.

C. Install control valves as required by Division 15 Section "HVAC Instrumentation and Control."

D. Install piping adjacent to convection heating units to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 238233

N:\N0912.00\DOC\SPEC\2012_03-16_BID\238233 - CONVECTORS .DOC

SECTION 238239 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Cabinet unit heaters with centrifugal fans and hot-water coils.
   2. Propeller unit heaters with hot-water coils.

1.3 DEFINITIONS

A. BICS: Building Internetworked Control System.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Location and size of each field connection.
   3. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   4. Location and arrangement of piping valves and specialties.
   5. Location and arrangement of integral controls.
   6. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Cabinet Unit Heater Filters: Furnish two spare filters for each filter installed.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide McQuay International or a comparable product by one of the following:
   1. Airtherm; a Mestek Company.
   2. Dunham-Bush, Inc.
   3. International Environmental Corporation.
   4. Trane.
   5. USA Coil & Air.

B. Description: A factory-assembled and -tested unit complying with ARI 440.

C. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be aluminum-foil facing to prevent erosion of glass fibers.
   1. Thickness: 1 inch.
   2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
   3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
   1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
   2. Control Access Door: Key operated.
   3. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.
   4. Extended Piping Compartment: 8-inch- wide piping end pocket.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
   2. Pleated: 90 percent arrestance and 7 MERV.

F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

G. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 15 Section "Motors."
   3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

H. Factory, Hot-Water Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet and outlet.
   1. Two-way, modulating control valve.
   2. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
      a. Length: 24 inches.
      b. Minimum Diameter: Equal to cabinet unit heater connection size.
   3. Two-Piece, Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
   4. Calibrated-Orifice Balancing Valves: Bronze body, ball or globe type, 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venture, connection for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
   5. Y-Pattern, Hot-Water Strainers: Bronze body; 125-psig minimum working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 threaded pipe and full-port ball valve in strainer drain connection.
   6. Wrought-Copper Unions: ASME B16.22.

I. Control devices and operational sequences are specified in Division 15 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

J. Basic Unit Controls:
   1. Control voltage transformer.
   2. Wall-mounting thermostat with the following features.
      a. Heat-off switch.
      b. Fan on-auto switch.
      c. Manual fan speed switch.
      d. Adjustable deadband.
      e. Concealed set point.
      f. Exposed indication.
      g. Deg F indication.
   3. Unoccupied period override push button.

K. Electrical Connection: Factory wire motors and controls for a single field connection.

L. Capacities and Characteristics: As scheduled on plans.

2.2 PROPELLER UNIT HEATERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide McQuay International products or comparable product by one of the following:
   1. Airtherm; a Mestek Company.

2. Trane.

B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

C. Cabinet: Removable panels for maintenance access to controls.

D. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

E. Discharge Louver: Adjustable fin diffuser for horizontal units.

F. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.

G. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

H. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

I. Fan Motors: Comply with requirements in Division 15 Section "Motors."
1. Motor Type: Permanently lubricated, multispeed.

J. Control Devices:
1. Wall-mounting fan-speed switch.
2. Wall-mounting thermostat.

K. Capacities and Characteristics
1. As scheduled on plans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cabinet unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure. Hanger rods and attachments to structure are specified in Division 15 Section "Hangers and Supports." Vibration hangers are specified in Division 15 Section "Mechanical Vibration Control."

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. New filters in cabinet unit heater within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Comply with safety requirements in UL 1995.

E. Unless otherwise indicated, install union and ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 15 Section "Hydronic Piping."

F. Ground equipment according to Division 16 Section "Grounding and Bonding."

G. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 238239

N:\N0912.00\DOC\SPEC\2012_03-16_BID\238239 - UNIT HEATERS.DOC

SECTION 260100 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provision of Contract, including Division 0 and Division 1 specifications, apply to this section. Where Paragraphs of this Section conflict with similar paragraphs of Divisions 0 and 1, most restrictive requirements shall govern work.

1.2 SUMMARY

A. This entire section forms an integral part of each, Electrical, section included in the 260000 series of the specifications.

B. Perform work and provide material and equipment as shown on Drawings and/or as specified and/or indicated in this Section of the Specifications. Completely coordinate work of this Section with work of other trades and provide a complete and fully functional installation.

C. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

D. Give notices, file plans, obtain permits and licenses, pay fees and back charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda, Revisions, and Change Orders, all of which are part of Contract Documents.

E. Examine Drawings and other Sections of Specifications for requirements that affect work of this Section.

F. Attention is directed to the following specialized requirements of this Section:
   1. Paragraph GUARANTEE AND 24-HOUR SERVICE. The requirement to provide a 24 hour phone number for service during the guarantee period is incorporated; also, an extended warrantee to cover the full one year contractor's guarantee period starting on the date of beneficial occupancy, even if equipment has been previously used for temporary heat or other purpose.
   2. Paragraph SUBMITTALS. A special cover sheet for each shop drawing, to be filled out by the contractor, is required. A description of "Acceptable Manufacturers" is included. No other manufacturers will be considered for this project. The turn-around time Vanderweil Engineers requires to process shop drawings is described.

1.3 DEFINITIONS

A. As used in these Sections, "provide" means "furnish and install." "Furnish" means "to purchase and deliver to the project site complete with every necessary appurtenance and support," and "Install" means "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project. "Architect" means the "Prime Design Consultant," and if Vanderweil Engineers is not the prime design consultant, the Architect may authorize Vanderweil Engineers to act on the Architect's

behalf in matters concerning the 26000 series of specifications. "RFI" means "Contractor's Request for Information."

1.4 CONTRACT DOCUMENTS

A. Listing of Drawings does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to Architectural, HVAC, Plumbing, Fire Protection, Electrical, and Structural, and all other Drawings and other Sections that indicate types of construction in which work shall be installed and work of other trades with which work of this Section must be coordinated.

B. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

D. Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify or to show every offset, pullbox, junction box fitting, and component. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

E. Information and components shown on riser diagrams, but not shown on plans, and vice versa, shall apply or be provided as if expressly required on both.

F. Data that may be furnished electronically by the Architect (on computer, diskette, CD, or otherwise) is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference, and shall not substitute for Architect's sealed or stamped construction documents.

G. Exact location of receptacles, light fixtures, exit signs, fire alarm devices, etc., shall be coordinated with the architectural drawings and shall not be scaled from locations indicated on the electrical drawings.

1.5 CAD FILES

A. CAD files for Electrical drawings will be furnished by the Engineer at Contractor's request. A processing fee will be charged, per division 01 specifications. Contractor shall sign a disclaimer regarding use of the drawings so transmitted.

1.6 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are unclear, advise Architect in writing before Award of Contract. Otherwise, Architect's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or unclarities thus resolved.

B. Where Drawings or Specifications do not coincide with manufacturers' recommendations, or with applicable codes and standards, alert Architect in writing before installation. Otherwise, make changes in installed work as Architect requires within Contract Price.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, this contractor shall provide that material, installation, or work which is of the higher standard.

D. It is the requirement of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the contractor has failed to notify the Architect of the situation in accordance with Paragraph (A) above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

E. In cases covered by paragraph above, where the contractor believes he needs engineering guidance, he shall submit a sketch identifying his proposed solution and the Architect shall review, note if necessary, and approve the sketch.

F. Where discrepancies exist between the mechanical, plumbing, fire protection, and electrical drawings in regards to what trade owns equipment such as disconnects, starters, etc., the discrepancy shall be brought to the Architect’s attention in accordance with paragraph (A) above. If the scope is not resolved prior to the Award of Contract, the Electrical Contractor shall provide such items.

1.7 MODIFICATIONS IN LAYOUT

A. Electrical Drawings are diagrammatic. They indicate general arrangements of electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet Architectural requirements.

B. In order to obtain the intended desired aesthetics in spaces used by building occupants, in all such spaces, prior to installation of visible material and equipment (including access panels), review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

C. Check Contract Drawings, as well as Shop Drawings, of all subcontractors to verify and coordinate spaces in which work of this section will be installed.

D. Maintain maximum headroom at all locations. All raceways, pull boxes, junction boxes, and associated components to be as tight to underside of structure as possible.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades and to coordinate according to paragraphs above. Systems shall be run in a rectilinear fashion.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.8 REQUEST FOR INFORMATION (RFI'S)

A. If the RFI is a request to resolve a conflict or an unclarity, or a request for additional detail, Contractor's RFI shall include a sketch or equivalent description of Contractor's proposed solution, in accordance with paragraphs above in “Discrepancies in Documents” and “Modifications in Layout” above.

1.9 RELATED WORK IN OTHER SECTIONS

A. The following work is not included in the 260000 Series Sections and shall be performed under other Sections.
   1. Concrete work, including concrete housekeeping pads and other pads and blocks for vibrating and rotating equipment.
   2. Cutting and patching of masonry, concrete, tile and other parts of structure, with the exception of drilling for hangers and providing holes and openings in metal decks.
   3. Flashing of wall and roof penetrations.
   4. Installation of access panels in floors, walls, furred spaces or above ceilings.
   5. Painting, except as specified herein.
   6. Structural supports necessary to distribute loading from equipment to roof or floor except as specified herein.
   7. Temporary light, power, water, heat, gas and sanitary facilities for use during construction and testing.

1.10 SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this Section. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

1.11 CODES, STANDARDS, AUTHORITIES AND PERMITS

A. Perform work strictly as required by rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have legal jurisdiction over the site.

B. Prior to commencement of work, notify State and applicable authorities as required and submit all of the applicable notifications for construction, operation and/or demolition.

C. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:
   1. Local and state building, electrical, fire and health department codes.
   2. National Fire Protection Association (NFPA).
   3. American Insurance Association (AIA) (formerly National Board of Fire Underwriters).
   4. Occupational Safety and Health Act (OSHA).
   5. Underwriters Laboratories (UL)
   6. Factory Mutual Association (FM)
   7. Owner’s Insurance Underwriter.

D. Material and equipment shall be listed by Underwriters' Laboratories (UL), and approved by ANSI and ASTM for intended service.

E. When requirements cited in this Specification conflict with each other or with Contract Documents, most restrictive shall govern work. Architect may relax this requirement when such

relaxation does not violate ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.

F. Most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents.
   1. American National Standards Institute (ANSI).
   2. National Electric Manufacturers Association (NEMA).
   3. American Society for Testing and Materials (ASTM).
   4. Institute of Electrical and Electronics Engineers (IEEE).
   5. Insulated Cable Engineers Association (ICEA).
   6. Certified Ballast Manufacturers (CMB).
   7. Illuminating Engineering Society (IES).
   8. National Electric Safety Code (NESC)

G. Specific reference is made to the following National Fire Protection Association (NFPA) codes which contain an exceptionally high quantity of electrical and fire protection requirements:
   1. NFPA No. 70 - National Electric Code- 2008 Edition
   2. NFPA No. 72 – National Fire Alarm Code
   3. NPFA No. 101 – Life Safety Code

1.12 GUARANTEE AND 24 HOUR SERVICE

A. Guarantee the Work of this Section in writing for one year following the date of beneficial occupancy. If the equipment is used for lighting, temporary electric service, etc. prior to initial beneficial occupancy by the Owner, the bid price shall include an extended period of warranty covering the one year of occupancy, starting from the initial date of beneficial occupancy by the Owner. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to Architect's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

B. In addition to guarantee requirements of Divisions 0, 1 and of paragraph above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner’s name.

C. Replace material and equipment that require excessive service during guarantee period as defined and as directed by Architect.

D. Provide 24 hour service beginning on the date of Substantial Completion and lasting until the termination of the guarantee period. Service shall be at no cost to the project. Service can be provided by this contractor or a separate service organization. Choice of service organization shall be subject to Architect and Owner approval. Submit name and a phone number that will be answered on a 24 hour basis each day of the week, for the duration of the service.

E. Submit copies of equipment and material warranties to Architect before final payment.

F. At end of guarantee period, transfer manufacturers' equipment and material warranties still in force to designated operations personnel.

G. This Paragraph shall not be interpreted to limit Owner's rights under applicable codes and laws and under this Contract.

H. Part 2 Paragraphs of the Specification sections may specify warranty requirements that exceed those of this Paragraph.

I. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute guarantee period.

J. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise Architect in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Architect will suggest course of action.

1.13 RECORD DRAWINGS

A. As work progresses and for duration of Contract, maintain complete and separate set of prints of Contract Drawings at job site at all times. Record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to the original design. Include actual location of existing utilities if they differ from design documents. Record location of all pull and junction boxes except standard 4" boxes as they are installed.

B. All panelboard feeder routing locations shall be shown on the record drawings.

C. Drawings shall show record condition of details, sections, riser diagrams, and corrections to schedules.

D. At completion of work, prepare a complete set of record drawings in electronic format. Deliver the following to the Engineer for approval.
1. CD delivered in AutoCAD 2009, or approved format drawings.
2. It is the Contractor's responsibility to configure the drawing layers consistent with Vanderweil Engineers format for this project. Drawing will otherwise be rejected.
3. One hard copy set of contract specifications (original Vanderweil Engineers specs) with all appropriate changes, marked in red stamped as "Record".
4. One set of blackline drawings stamped "record" and signed by the appropriate subcontractor. A hard copy of Record Drawings must indicate changes and deviations from design by the use of revision clouds.

E. The design tracings will be made available for the contractor's copying, at his expense, into vellum reproducibles to serve as backgrounds for the drawings. The quantity of design tracings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required information. Contractor's professional draftsperson shall incorporate changes and submit three sets of prints for comments as to comply with this section.

F. The Installing Contractor shall certify Record Drawings for accuracy. This is the sole responsibility of the contractor.

G. Submit the record set for approval by the Authority Having Jurisdiction in a form acceptable to the Authority, when required by the jurisdiction. Such drawing format size changes, and supplemental information required for the submittal are the requirement of the contractor.

1.14 BULLETINS, MANUALS, AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in coordinated manuals with additional information describing combined operation of field assembled units, including as-built wiring diagrams.

Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment. Divide manuals into two sections or books as follows:

1. Directions for and sequence of operation of each item of the Electrical systems; i.e., panelboards, transformers, fire alarm, etc. Sequence shall list operations for systems and other devices used to start, stop and control system. Detail procedure to be followed in case of malfunctions. Include detailed approved riser or one-line diagrams of systems provided. Include schedules identifying equipment served.
2. Detailed maintenance and trouble shooting manuals containing data furnished by manufacturer for complete maintenance.

B. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

C. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Instructions shall be performed by factory-trained personnel. Owner shall determine which systems require additional instructions. Duration of instructions shall take equipment through complete cycle of operation (at least five working days). Make adjustments under operating conditions.

1.15 PROTECTION OF WORK

A. Each contractor shall be responsible for his work and equipment until finally inspected, tested, and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material.

B. Provide all materials, equipment and labor to provide adequate protection of all electrical equipment during the course of construction. This includes protection from moisture and foreign material.

C. Each separate contractor shall protect the work and material of other trades that might be damaged by his work or workmen and make good all damage thus caused.

1.16 SUBMITTALS

A. This Paragraph supplements section 01300- Submittals.

B. Definitions:

1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than shown in the Contract Documents.
2. Coordination Drawings are detailed, large-scale layout Shop Drawings showing HVAC, Electrical, Plumbing and Fire Protection work superimposed in order to identify conflicts and ensure inter-coordination of Mechanical, Plumbing, Fire Protection, Electrical, Architectural, Structural and other work.

C. Submittal Cover Sheet

1. Shop drawing submittal for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Shop drawings shall be submitted according to specification section with a separate cover sheet completed for each product, rather than one cover sheet for multiple products,

whether or not supplied by one manufacturer or vendor.

SHOP DRAWING COVER SHEET

SHOP DRAWING COVER SHEET			
PROJECT:	CONTRACTOR:		
DIVISION NO.:	SECTION NO.:		
DESCRIPTION:			
CONTRACT DRAWING REFERENCE NO:			
EQUIPMENT TAG:			
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH			
DATE:			
INFORMATION AND CHECKLIST			
1.	Contractor's Log #ID		
2.	Name, address, and phone number of supplier.		
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes No	
4.	Is this item a substitution?	Yes No	
5.	Are deviations clearly identified?	Yes No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes No	
11.	Is control interface coordinated?	Yes No	
12	List electrical characteristics (V/Ph/A)		

D. Submittal Procedures and Format

1. Review submittal packages for compliance with Contract Documents before submitting. Review by the Contractor is intended to ensure that the shop drawings contain adequate information to verify each specification requirement as well as the performance and dimensional requirements shown on the drawings BEFORE submission. If a shop drawing is returned with a "rejected" or "review and resubmit" it indicates that the shop drawing was not adequately reviewed by the Contractor. Subsequent submittals shall include written response to previous comments.
2. Submit transparency and two blue- or black-line reproductions of each Shop Drawing larger than 8½ x 11. Submit four sets of each smaller shop drawing. After review, transparency original of each large Shop Drawing and three sets of each small shop drawing will be returned with reviewer's marks.
3. Provide additional copies of reviewed shop drawings as required for full distribution.
4. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be ¼" = 1'-0" scale unless specified otherwise.
5. Shop drawings showing manufacturer's product data shall contain detailed dimensional drawings, weights, construction details, installation, operation and maintenance manuals, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents. Include all applicable manufacturer warranties and details involving other trades.
6. Faxes shall not constitute a shop drawing and will not be reviewed as such. Proper submittals shall be made in a timely fashion.
7. General catalog cuts without identifying the proposed product will not be reviewed. Options not included shall be crossed out so as not to imply they are included. Clearly indicate the specific piece of equipment being provided.

E. Acceptable Manufacturers: The electrical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. These are acceptable only if, as a minimum, they:

1. Meet all performance criteria listed in the schedules and outlined in the specification. For example, to be acceptable, a light fixture must have the same or better photometrics as the light fixture listed in the schedules.
2. Have identical operating characteristics to those called for in the specification. For example, a two stroke diesel generator will not be acceptable if a four stroke model is specified.
3. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.
4. For rooftop mounted equipment and for equipment mounted in areas where structural matters are a consideration, the products must have a weight no greater than the product listed in the schedules or specifications.
5. Products must adhere to all architectural considerations including, but not limited to: being of the same color as the product scheduled or specified, fitting within architectural

enclosures and details, and for lighting fixtures - being the same size and of the same physical appearance as scheduled or specified products.

6. All equipment of one type such as distribution equipment (panelboards, transformers, etc.) shall be a product of one manufacturer unless noted otherwise and approved by the Engineer.

F. Required Use of Acceptable Manufacturers on this Project:

1. Substitution of products other than those of the Acceptable Manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified Alternate Manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.

G. Deviations

1. Concerning deviations, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of Shop Drawings which flags the deviation to the attention of the Architect.
2. Without letters flagging the deviation to the Architect, it is possible that the Architect may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Architect, the contractor shall hold the Architect and his consultants harmless for any and all adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the shop drawings containing the deviation, has been reviewed and approved and will be strictly enforced.
3. Approval of proposed deviations, if any, will be made at discretion of Architect.

H. Submittal Notations: Submittals will be returned from the Architect marked as illustrated below:

"REVIEWED"

"Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with."

"REVIEWED, DEVIATIONS NOTED; REVISE AND RESUBMIT"

"Submittal contains deviations which must be corrected and confirmed by a new submittal."

"REJECTED"

Submittal is incorrect to such an extent that material is unacceptable, or is incomplete to such an extent that a complete review cannot be made. Resubmit in accordance with requirements of the Contract Documents."

"NO ACTION"

Submittal not reviewed.

I. Responsibility

1. Intent of Submittal review is to check for capacity, rating, and certain construction features. Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this and other Sections. Work shall comply with submittals marked "REVIEWED" to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. The noting of some errors while overlooking

others will not excuse the contractor from proceeding in error. Contract Documents requirements are not limited, waived nor superseded in any way by review.

2. INFORM SUBCONTRACTORS, MANUFACTURERS, SUPPLIERS, ETC. OF SCOPE AND LIMITED NATURE OF REVIEW PROCESS AND ENFORCE COMPLIANCE WITH CONTRACT DOCUMENTS.

J. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. Contractor shall assume full responsibility for delays caused by not incorporating the following shop drawing review time requirements into his project schedule. Working days listed reference the time in the Engineer's office. It does not include transmittal time. Allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that 20 working days, exclusive of transmittal time, are required for the following:

1. Coordination Drawings.
2. If more than five shop drawings are received in one calendar week.

K. List of Proposed Equipment and Materials

1. Within four weeks after Award of Contract and before ordering materials or equipment, submit complete list of proposed materials and equipment and indicate manufacturer's names and addresses. No consideration will be given to partial lists submitted out of sequence.

1.17 COORDINATION DRAWINGS

A. A single set of coordination drawings shall be mutually prepared by all mechanical and electrical trades.

B. The initiation of these drawings begins with the Mechanical Contractor.

C. The Mechanical Contractor will prepare a complete set of background drawings, showing structure and other information as needed for coordination. He shall show sheet metal layout thereon. These will be the Coordination Drawings.

D. Each trade shall add its work to these background drawings with appropriate elevations and grid dimensions. Specialty trade information is required for mechanical rooms, electrical rooms, and for spaces in and above ceilings where congestion of work may occur such as corridors, and even entire floors. Drawings shall indicate horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions, and other services.

E. Refer to Specification Section 260500 Section “Common Work Results for Electrical,” for coordination of equipment location.

F. Each trade shall sign and date coordination drawing. Return drawings to the Mechanical Contractor, who shall route them sequentially to all trades.

G. Where conflicts occur with placement of materials of various trades, the Mechanical Contractor will be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by the specialty trade. The Mechanical Contractor shall then final date and sign each drawing. If conflicts cannot be resolved, the decision of the General Contractor/Construction Manager shall be final.

H. A Subcontractor who fails to promptly review and incorporate his work on the drawings shall assume full responsibility of any installation conflicts affecting his work and of any schedule ramifications.

I. Mechanical Contractor shall make composite copies of all coordination drawings. Fabrication shall not start until such transparencies of completed coordination drawings are received by the Architect/Engineer and have been reviewed.

J. Review of coordination drawings shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with Architectural, Structural, Mechanical, Electrical and other work.

K. After Review:
1. After review of coordination drawings, the method used to resolve interference not previously identified shall be as in "MODIFICATIONS IN LAYOUT" above.
2. All changes to reviewed coordination drawings shall be in writing by the Architect/ Engineer prior to start of work in affected area.

L. Distribution of Coordination Drawings:
1. The Mechanical Contractor shall distribute the documents.

M. All firewalls and smoke partitions and other required barriers, must be highlighted on the coordination drawings for appropriate coordination.

N. The main paths of egress and for equipment removal, from electrical rooms must be clearly shown on the coordination drawings.

O. Coordination Drawings shall include, but are not limited to:
1. Electrical distribution, systems and equipment.
2. Lighting fixtures.
3. Electrical Equipment Room layouts.
4. Access panels.
5. Major electrical conduit runs, panelboards, feeder conduit and racks of branch conduit.
6. Cable trays for telecommunication cabling.

PART 2 - PRODUCTS

A. Refer to specific sections for product specifications.

PART 3 - EXECUTION

3.1 LIFE SAFETY SYSTEMS CERTIFICATION OF COMPLETION

A. Definitions
1. Life Safety Systems - Mechanical and electrical systems including:
   a. Fire Suppression Systems
   b. Fire Notification (Alarm) and Detection Systems
   c. Egress Signage and Lighting Systems
   d. Emergency Power Systems
2. Complete - For a system to be complete the following shall be true:
   a. No further work is required to satisfy the requirements specified in the drawings, specifications and applicable codes and standards.
   b. Systems are fully operational with power to components, status indicators in "normal" condition and otherwise ready "as-is" to perform required functions.

c. Required product data and shop drawing submittals have been submitted and returned with a "Reviewed" status. See appropriate Division 16 Sections for submittal requirements.

d. Test certificates have been submitted and returned with a "Reviewed" status. See appropriate Division 16 Sections for submittal requirements.

e. Project visit report observations and "punch list" items have been addressed and/or corrected to the satisfaction of the Architect/Engineer.

f. "O&M" documentation and "as-built" plans have been submitted and returned with a "Reviewed" status.

B. Notification of Completion

1. Schedule the work such that life safety systems are complete in advance of other systems such that the Architect/Engineer may conduct a final project visit once notified of completion and any final issues may be addressed without affecting issuance of a Certificate of Occupancy by the Authorities Having Jurisdiction.

3.2 SPECIAL RESPONSIBILITIES

A. Cooperate and coordinate with work of other Sections in executing work of this Section.

1. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.
2. Provide information as requested on items furnished under this Section which shall be installed under other Sections.
3. Obtain detailed installation information from manufacturers of equipment provided under this Section.
4. Obtain final roughing dimensions or other information as needed for complete installation of items furnished under other Sections or by Owner.
5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information in proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Architect.
6. Provide information as requested as to sizes, number and locations of concrete housekeeping pads necessary for floor-mounted vibrating and rotating equipment provided under this Section.
7. Notify Architect of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Architect, relocate piping, ductwork and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned raceway, wiring, and equipment as directed by Architect. Dispose of or store items as requested by Architect.

B. Installation Only Items

1. Where this contractor is required to install items which it does not purchase, it shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This trade shall be responsible for:
   a. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.

b. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

2. This contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted this contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

C. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

D. Use of premises: Use of premises shall be restricted as directed by Architect and as required below.

1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of Architect.
2. Store materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
3. Do not interfere with function of existing systems and services. Extreme care shall be observed to prevent debris from entering raceways and equipment. Confer with Architect as to disruption of services or other utilities due to testing or connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation. Obtain Owner's approval of the method proposed for minimizing service interruption.

E. Surveys and Measurements:

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct laying out of work.
2. In event of discrepancy between actual measurements and those indicated, notify Architect in writing and do not proceed with work until written instructions have been issued by Architect.

F. Fireproofing:

1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.
2. Raceways and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
3. Patching and repairing of fireproofing due to cutting or damage to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for an extra to Owner.

G. Temporary Utilities:

1. Refer to Division 1 regarding requirements.

H. Miscellaneous

1. Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving electrical equipment on and around site, in building or on roof.

3.3 PROJECT CLOSE-OUT PROCEDURE

A. General

1. The requirements of this section are in addition to and supplement the requirements outlined in Section 01700- Project Closeout.
2. It shall be each contractor's responsibility to personally hand-deliver all of the required project close-out checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off.

B. Project Close-Out Checklist

1. Review requirements of each section of the specifications and submit for approval to Architect the sign-off forms which shall become the project close-out checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Architect and/or Owner may incorporate additional specific items to the following checklist which shall become part of the project requirements.
2. Close-Out Checklist Example.

PROJECT CLOSE-OUT

PROJECT CLOSE-OUT			
PROJECT:			
DIVISION NO.:			
CONTRACTOR:			
ITEM[1]	DATES		OWNER'S SIGN-OFF
	COMPLETED	RECEIVED BY OWNER	
Permits			
State Inspection			
Manufacturer's Warranties			
Contractor's Warranties			
State Fire Rating Data			
Copy of Final Shop Drawings			
List and Possession of Spare Parts			
Equipment Tests Required by Specs			
O & M Manuals			
Record Documents			
Coordination Drawings			
Commissioning Reports/Letters/Forms			
On Site Training Complete			
Protective Device Settings			
Insurance Underwriters Approvals			
Final Punch List (Initialed by contractor that items are complete)			
Building Certificate of Occupancy (CO)			
24 Hour Phone No. for Service During Guarantee Period			

END OF SECTION 260100

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260100_FL.DOC

[1] Provide separate line item for each specified item (do not group items).

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   4. Grout.
   5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260500_COMMON WORK RESULTS.DOC

SECTION 260500.01 – COMMON WORK RESULTS FOR ELECTRICAL, SECURITY SUPPLEMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide a conduit and supportive electrical powering systems to support Electronic Security Systems as listed in paragraph 1.1. Coordinated with Section 280500 work. See submittal requirements for submittal requirements.

B. Refer to 280500 Part 1

1.2 RELATED DOCUMENTS

A. Refer to 280500 Part 1

1.3 RELATED DIVISION PROVISIONS

A. Refer to 280500 Part 1

1.4 REFERENCES

A. Refer to 280500 Part 1

1.5 SUMMARY

A. Section includes requirement of Division 26 contractor to support electronic security systems work. This section provides requirements for planning, supplementary submittal requirements, product specifications and installation of conduit and electrical power systems supporting electronic security.

1.6 DEFINITIONS

A. Refer to 280500 Part 1

1.7 SUBMITTALS

A. General: Submittals shall adhere to submittal requirements outlined in Division 280500, Section 1.6. All submittals for Section 280500 including this supplement shall be submitted as one submittal as outlined in Section 280500, Paragraph 1.6.

B. Group 1 Technical Data Package: The data package shall include the following:

1. Shop Drawings: Provide conduit systems plan for routing and sizing of all security conduits and enclosure assemblies.

2. Construction Mock-up: In areas with exposed EMT/Conduit Raceways, Contractor shall conceal raceway as much as practical and unobtrusively. Installation means and methods should be approved by the Owner.

3. Power Circuits & Calculation: Contractor shall provide power circuit schedule for each security component requiring high voltage power. The schedule shall include the following information:

a. Panel Location
b. Panel Nomenclature
c. Circuit Number
d. Type of Circuit (emergency power, UPS, etc.)
e. Circuit power consumption

C. Product Data: For each type of product indicated in Part 2 of this section.

1.8 COORDINATION

A. Refer to 280500 Part 1

1.9 QUALITY ASSURANCE

A. Refer to 280500 Part 1

1.10 MAINTENANCE & SERVICE

A. Refer to 280500 Part 1

1.11 SYSTEM DESCRIPTION

A. The system shall be coordinate with 280500.

1.12 PERFORMANCE REQUIREMENTS

A. Refer to 280500 Part 1

1.13 DELIVERY HANDLING & STORAGE

A. Refer to 280500 Part 1

1.14 PROJECT CONDITIONS

A. Refer to 280500 Part 1

1.15 EQUIPMENT AND MATERIALS

A. Refer to 280500 Part 1

1.16 ELECTRICAL POWER

A. Refer to 280500 Part 1

1.17 ENVIRONMENTAL CONDITIONS

A. Refer to 280500 Part 1

1.18 LIGHTNING, POWER SURGES, & GROUNDING

A. Refer to 280500 Part 1

1.19 COMPONENT ENCLOSURES

A. Refer to 280500 Part 1

1.20 ELECTRONIC COMPONENTS

A. Refer to 280500 Part 1

1.21 SUBSTITUTE MATERIALS & EQUIPMENT

A. Refer to 280500 Part 1

1.22 LIKE ITEMS

A. Refer to 280500 Part 1

1.23 WARRANTY

A. Refer to 280500 Part 1

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All materials, equipment, and devices shall, as a minimum, meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70. All items shall be new unless specified or indicated otherwise.

2.2 CONDUIT AND FITTINGS

A. Types:

1. Rigid:

a. Rigid Steel Conduit (Zinc-Coated) shall meet ANSI C80.1.
b. Rigid Aluminum Conduit shall meet ANSI C80.5.
c. Rigid Nonmetallic PVC Type Conduit EPC-40 in accordance with NEMA TC2, or UL approved fiberglass reinforced epoxy (FRE).
d. Conduit coupling and connectors shall be of a compression type. Set screw couplings and connectors shall not be permitted.

2. EMT:

a. Electric Metallic Tubing (EMT) shall meet ANSI C80.3.
b. Conduit coupling and connectors shall be of a compression type. Set screw couplings and connectors shall not be permitted.

3. Flexible Metal Conduit:

a. Liquid-Tight Flexible Metal Conduit (Steel) shall meet UL 360.

4. Sheet Metal Cable Tray

a. Sheet Metal Cable Tray shall meet National Electrical Manufacturer's Association (NEMA) VE1-2002.

2.3 SPECIAL FIRE PANEL CONNECTIONS

A. All conduits between the security panel assembly and fire control panels are to be recessed in the wall. These conduits shall be marked with blue and red tape to indicate their association with fire and security systems.

2.4 SECURITY JUNCTION BOX:

A. The Contractor shall provide 6” x 8” metal junction box with cover and tamper proof Torx Center post security screws. Boxes containing security electronic circuitry shall be tampered.

2.5 ENCLOSURES:

A. The Contractor shall provide metallic enclosures as needed for equipment not housed in racks or supplied with a housing. The enclosures shall be as specified or shown.

1. Interior: Enclosures to house equipment in an interior environment shall meet the requirements of NEMA 250-Type 12.

2. Exterior: Enclosures to house equipment in an outdoor environment shall meet the requirements of NEMA 250-Type 4. Enclosures exposed to direct sunlight shall be finished with white polyester powder coating and be equipped with a sun shield finished to match the enclosure. Sun shield shall be mounted to protect the top of the enclosure from direct sun and shall extend at least 25.4 mm (1 in) beyond the edges of the enclosure on all sides.

3. Corrosion-Resistant: Enclosures to house equipment in a corrosive environment shall meet the requirements of NEMA 250-Type 4X.

4. Hazardous Environment: All system electronics to be used in a hazardous environment shall be housed in a metallic enclosure which meets the requirements of paragraph "Hazardous Environment."

5. Tamper Provisions: Enclosures, cabinets, housings (other than environmental camera housings), and boxes of every description having hinged doors or removable covers, which contain any part of the data transmission media, circuits, termination or power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode; and be wired so they break the circuit when the door or cover is disturbed. Tamper switches on the doors which must be opened to make routine maintenance adjustments to the system and to service the power supplies shall be push/pull-set, automatic reset type.

6. Enclosure Covers: Covers of pull and junction boxes provided to facilitate installation of the system need not be provided with tamper switches if they contain no splices or connections and held in place with tamper proof Torx Center post security screws. Provide stenciled labels for each box.

7. Construction of Enclosures:

   a. Consoles, power supply enclosures, detector control and terminal cabinets, control units, wiring gutters, and other component housings, collectively referred to as enclosures, shall be so formed and assembled as to be sturdy and rigid.

   b. Thickness of metal in-cast and sheet metal enclosures of all types shall not be less than those in Tables I and II, UL 611. Sheet steel used in fabrication of enclosures shall be not less than 14 gauge. Consoles shall be 16-gauge. Doors and covers shall be flanged. Enclosures shall not have pre-punched knockouts. Where doors are mounted on hinges with exposed pins, the hinges shall be of the tight pin type or the ends of hinge pins shall be tack welded to prevent removal. Doors having a latch edge length of less than 609.6 mm (24 in) shall be provided with a single construction core. Where the latch edge of a hinged door is more than 609.6 mm (24 in) or more in length, the door shall be provided with a three-point latching device with construction core; or alternatively with two, one located near each end.

   c. Any ventilator openings in enclosures and cabinets shall conform to the requirements of UL 611. Unless otherwise indicated, sheet metal enclosures shall be designed for wall mounting with tip holes slotted. Mounting holes shall be in positions that remain accessible when all major operating components are in place and the door is open, but shall be in accessible when the door is closed.

   d. Covers of pull and junction boxes provided to facilitate initial installation of the system shall be held in place by tamper proof Torx Center post security screws. Stenciled or painted labels shall be affixed to such boxes indicating they contain no connections. These labels shall not indicate the box is part of the Electronic Security System (ESS).

B. Wire Troughs

   1. Wire troughs shall be utilized for all enclosure assemblies wire management practices.

   2. Security Screws: Secure trough covers with tamper proof Torx Center post security screws.

   3. Trough Mounting: Wire Toughs shall be mounted securely to fire resistant plywood meeting UL Standard for fire retardant backboards.

PART 3 - EXECUTION

3.1 GENERAL

A. Power (Division 26):

1. Primary Dedicated Electrical Power (20 Amp, 120 VAC) circuits shall be provided by this Contractor at locations shown on drawings. Primary Dedicated Electrical Power (20 Amp, 120 VAC) circuits shall be derived from sources supported emergency power. The Contractor shall provide all the connections between powered junction boxes and security equipment.

2. Division 26 Contractor shall provide cable trays required by the security systems. Security conduits shall be labeled with blue marking band or blue paint every 30 ft Security junction box covers shall be painted with paint manufactured by Benjamin Moore #791, or Duron 5085A (Americana).

B. HVAC (Division 25)

1. Division 25 Contractor shall provide a Liebert Cooling System or equivalent, for the Security Monitoring Control and Equipment rooms.

C. Conduit: The following security provisions apply to system conduit requirements:

1. Conduit shall be provided in accordance with The National Electrical Code (NEC), and the requirements of other Division 26 Sections.

2. All wiring shall be installed in conduit and in cable trays or raceways when specifically permitted in Contract Documents. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per the NEC.

4. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter the security control panel, or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the manufacturer.

6. Conduit shall be 3/4" minimum, except 1/2" flexible conduit is permitted when connecting to a single device.

D. Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose. Screws extending outside any cabinets shall be cut off and filed smooth to prevent any injury.

2. The security 120 VAC power supplies shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as Security. Security 120 VAC primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to a suitable ground.

3. Enclosure Penetrations: All enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

4. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

5. Wire Troughs: Wire troughs shall be utilized for all enclosure assemblies wire management practices. Security Screws: Secure trough covers with tamper proof Torx Center post security screws. Trough Mounting: Wire Toughs shall be mounted securely to fire resistant plywood meeting UL Standard for fire retardant backboards.

6. Backboards: Plywood, fire-retardant treated, 19 x 1220 x 2440 mm (0.75 x 48 x 96 in) minimum with actual dimensions to match panel assembly sizing. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

PART 4 - SYSTEM PROGRAMMING

4.1 NOT APPLICABLE

PART 5 - TESTING AND ACCEPTANCE

5.1 FIELD TESTS:

A. Contractor shall perform field test of all electrical circuits to ensure they conform to project requirements. A ground test shall be performed on all grounding systems to ensure continuity in the entire grounding system.

B. Unit Control Room

1. Contractor shall confirm the source, operation, and labeling of all power circuits.

5.2 REFER TO 280500 PART 5

END OF SECTION 260500 - SUPPLEMENT

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Senator Wire & Cable Company.
4. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN.

D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire. Lengths of multiconductor cable shall be limited to six feet for recessed lighting circuits and ten feet for receptacle circuits. Multiconductor cable shall not be utilized for homeruns back to panelboards.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or Metal-clad cable, Type MC. Multiconductor cable shall not be utilized for homeruns back to panelboard.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Common Work Results for Electrical."

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
      a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260519 FL - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.DOC

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Where Paragraphs of this Section conflict with similar paragraphs of the General and Supplementary Conditions and Division 1, requirements of this Section shall prevail.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Common ground bonding with lightning protection system.

B. Equipment grounding system shall be designed so metallic structures, enclosures, raceways, cable tray, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with electrical circuits operate continuously and ground potential and provide low impedance path for possible ground fault currents.

C. Related Sections:
   1. Division 27, Grounding and bonding for Communication Systems.
   2. Division 26, Lightning Protection for Structures.

1.3 REFERENCES

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
   1. NFPA 70 National Electrical Code
   2. NFPA 780 Standard for the Installation of Lightning Protection Systems
   3. UL 96 UL Standard for Safety for Lightning Protection Systems
   4. UL 467 Grounding and Bonding Equipment
   5. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
   6. IEEE/ANSI 142 Latest Edition Recommended Practice for Grounding of Industrial and Commercial Power Systems
   7. ASTM B3 Solid Conductors
   8. ASTM B8 Assembly of Stranded Conductors
   9. ASTM B33 Tinned Conductors
   10. NEMA GR1 Ground Rods and Ground Rod Couplings

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Test wells.

2. Ground rods.
3. Ground rings.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings and grounding connections for separately derived systems based on NETA MTS.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

b. Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Feeder and Branch Circuit Equipment Ground Conductors: Copper stranded conforming to ASTM B8 and B33wire or cable insulated for 600 V sized as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Insulation class other than 600V shall only be provided where otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Grounding Electrode Conductors: Bare, stranded cable of size shown on drawings, specifications or as required by NFPA 70, whichever is larger.
1. Stranded Conductors: ASTM B 8.
2. Solid Conductors: ASTM B 3.

C. Grounding Bus: Provide ground bus where specified and required.
1. Grounding Bus Material: Rectangular bars of bare electro-tin plated copper, (1/4 by 2 inches in cross section, minimum 20 inch length unless otherwise indicated; with insulated standoffs and stainless steel fasteners.
2. Ground Bus shall be UL 467 listed.
3. Field modification or cut bus shall not be acceptable.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Mechanical Connectors: Provide mechanical connectors of the two bolt type, listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
   1. Pipe Connectors: Clamp type, sized for pipe.
   2. Materials: The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolted pressure type. Split bolt connector types shall NOT be accepted.
   3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

C. Compression Connectors: Provide compression connectors that meet or exceed the performance requirements of IEEE 837, latest revision. Compression connectors shall be listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
   1. Materials: The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.
      a. The installation of the connectors shall be made with a compression tool and die system as recommended by the manufacturer of the connectors.
      b. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compressions tool settings.
      c. Each connector shall be factory filled with an oxide-inhibiting compound.

D. Welded Connectors: Provide exothermic connections for copper to copper and copper to steel connections to ground rods, ground buses, ground wires, steel beams, rebar, etc.
   1. The supplier of the equipment shall provide with no additional charge and information or supervision required for the proper installation of the equipment and training of operating personnel
   2. Materials: Conductors spliced with an exothermic welded connection shall be considered as a continuous conductor, as stated in the notes accompanying NEC articles 250.50, 250.64 and IEEE Standard 80 (latest edition).
      a. Procedures outlined in the Manufacturer's installation instruction shall be followed. Molds shall not be modified during installation in field applications.
      b. Weld metal shall be a mixture of copper oxide and aluminum. Only one weld metal mixture shall be required for each grounding connection.
      c. Grounding connections shall be tested and certified in accordance with IEEE 837, UL 486A and UL 467.
   3. All exothermic Connections shall:
      a. Prove to carry more current than the conductor.
      b. Not deteriorate during the life of the connection.
      c. Will not loosen or corrode during the life of the connection.
      d. Resist repeated fault currents without failure.
      e. Be of high visually discerned quality.
      f. Eliminate electrolytic penetration of conductors (strands).

2.3 GROUNDING ELECTRODES

A. Ground Rods: Ground Rods shall be Copper-clad steel; 3/4 inch by10 feet in diameter unless otherwise specified with a tensile strength not less than 75,000 psi. Copper shall be applied electrolically forming a metallurgical bond between the steel core and the copper
   1. Provide ground rods where shown or required to obtain the ground resistance specified in Part 3.

2.4 TEST WELLS

A. Polymer Concrete Inspection Wells
   1. Constructed of polymer concrete reinforced with heavy weave fiberglass resulting in high strength and minimal weight
   2. Enclosures and covers are rated for 10,000 lbs maximum load
   3. Bolt down cover, skid resistant surface

PART 3 - EXECUTION

3.1 GENERAL

A. Install Products in accordance with manufacturer's instructions.

B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.

C. Ground connection surfaces shall be cleaned prior to connections.

D. Attach grounds permanently before building service is energized.

E. Provide bonding to meet Regulatory Requirements.

F. Examine raceway, equipment or area to receive grounding to provide adequate sizes, placement and materials for a complete installation.

G. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A.

H. Determine numbers and sizes of screw terminals for equipment grounding bars in panelboards and other electrical equipment. Provide screw terminals for active circuits, spares and spaces.

I. Provide equipment ground conductor in same raceway with associated phase conductors.

3.2 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
   1. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

D. Conductor Terminations and Connections:

   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before handhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into handhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Pad-Mounted equipment including Transformer, and Generator: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items by connecting them to underground cable and grounding electrodes. Conductor shall be not less than No. 4/0 AWG for loop around pad and for taps to equipment ground pad. Bury conductors 24 inches below grade and 12 inches from the foundation. Below grade connections shall be made with Exothermic weld.
   1. Bond pad mounted equipment ground system to building grounding electrode system.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.
   7. Metal-clad cable runs.
   8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-20-inch grounding bus.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
   3. Provide ground wire from cable tray to ground bus. Provide manufacturers recommended connections to cable tray.
   4. All riser ground wire connections to ground bus shall be exothermic. All equipment ground connections to ground bus shall be mechanical connectors.
   5. Use minimum No. 6 AWG copper conductor, or as indicated on the plans, for communications system grounding conductor.
   6. Bond raceway containing communications cable that touches or is within 4 feet of cable tray

F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
   2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Raceways and Boxes for Electrical Systems," and shall be at least 12 inches deep, with cover.
   1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

H. Ground Ring: Install a supplementary grounding electrode consisting of ground rods and wire around the perimeter of the building and connecting to steel columns. When ground rods are not shown on the drawings provide a ground rod at every other column with a maximum spacing of 40'.
1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building foundation.
3. The perimeter ground wire shall be bonded to each ground rod with an exothermic connection. Provide a No. 4/0 AWG copper ground wire connections from the grounding loop to columns via exothermic connections.
4. Drive ground rods until tops are 24" below final grade unless installed in ground test well.
5. Ground rods shall be driven to achieve resistance required by this Section. Provide additional rods as required to achieve specified resistance. Where geological conditions dictate, ground wire mesh may be provided or additional rods shall be driven in compacted earth areas as require to meet resistance requirement.
6. Connections to ground loop system shall be made with Exothermic weld.
7. Verify that final backfill and compaction has been completed before driving ground rod electrodes.
8. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching , storing of dirt, cable laying and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2. Restore disturbed paving as indicated.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:
1. Visual inspection of all systems, raceway and equipment grounds shall be made to determine the adequacy and integrity of the grounding. All ground testing results shall be properly recorded, witnessed, and reported to the Contractor.

2. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

    b. Perform tests by fall-of-potential method according to IEEE 81.
        1) Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
        2) Ground tests shall be performed using a low resistance, Null balance type, ground testing ohmmeter, with test lead resistance compensated for. Measure the resistance of the ground under test and remote earth or a reference ground as specified. The test instrument shall be the type which compensates for potential and current rod resistances.
        3) Test completed grounding system at the service disconnect enclosure grounding terminal and at ground test wells. Perform tests, by the fall-of-potential method according to IEEE 81.
        4) Testing record shall include drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
4. Where ground test results indicate the need for additional grounding conductors or rods that are not indicated on drawings or specified, design changes will be initiated to obtain the acceptable values. The Subcontractor is responsible for the proper installation of the grounding shown on drawings or specified and for the correction of improper installations as determined by inspections and tests.
5. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system resistance shall be 5 ohms or less.

D. Report measured ground resistances that exceed the following values:

1. Power Distribution Units or Panelboards Serving Electronic Equipment: 5 ohm(s).

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260526_GROUNDING AND BONDING.DOC

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. Fabco Plastics Wholesale Limited.
      d. Seasafe, Inc.
   3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
   4. Fitting and Accessory Materials: Same as channels and angles.
   5. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel springhead type.
   7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slottedsupport system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Spring-tension clamps.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260529 FL - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.DOC

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, and underground utility construction.
2. Division 27 Section "Telecommunication Cabling Systems" for multi-media floor boxes.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:
a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.
c. Grounding details.

C. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6: zinc-coated steel.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit or IMC.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel or aluminum.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Fittings for EMT: Steel compression type. Set screw type shall be unacceptable.

I. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.

7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.
13. National Pipe and Plastics, Inc.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, [Type EPC-40-PVC,] unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.
4. Austin

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Flanged-and-gasketed type.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

E. Metal Floor Boxes:
1. Material: Sheet metal
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.

G. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.
1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as indicated for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis
e. Quazite

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit or IMC.
   2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, or EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
   6. Outdoors: System Electronics Enclosures: NEMA 250, Type 4.
   7. System Electronics Enclosures in Corrosive Environment: NEMA 250, Type 4X.
   8. Application of Handholes and Boxes for Underground Wiring:
      a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
      b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
      c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC with cast metal device boxes. Includes raceways in the following locations:
      a. Loading dock or area.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   5. Damp or Wet Locations: Rigid steel conduit or IMC with cast metal device boxes.
   6. Raceways for Optical Fiber or Communications Cable: EMT.
   7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
   8. System Electronics Enclosures: NEMA 250, Type 12.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where otherwise required by NFPA 70.

M. Expansion/Deflection Fittings
   1. Raceway buried or secured rigidly on opposite sides of building expansion joints and long runs of exposed raceway subject to stress due to thermal expansion shall have expansion/deflection fittings. Fittings shall safely deflect and expand to twice distance of structural movement.
   2. Provide separate external copper bonding jumper secured with grounding straps on each end of fitting, when integral ground is not provided.
   3. Raceways buried in concrete shall cross building expansion joints at right angles; provide expansion fittings as required by manufacturer's instructions. Provide insulated bushings at ends of raceways.
   4. Coordinate location of expansion/deflection fittings with the structural and architectural drawings.

N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

Q. Set metal floor boxes level and flush with finished floor surface.

R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."

3. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

4. Warning Tape: Bury warning tape approximately 12 inches above direct-buried conduits. Align tape along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be

long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260533_RACEWAY AND BOXES.DOC

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.

B. Related Sections:
   1. Division 27 Section "Telecommunication Cabling Systems" for pathways which serve telecommunications cabling.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

B. RSC: Rigid Steel Conduit.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Duct-bank materials, including separators and miscellaneous components.
   2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.7 COORDINATION

A. Coordinate layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ARNCO Corp.
   2. Beck Manufacturing.
   3. Cantex, Inc.
   4. CertainTeed Corp.; Pipe & Plastics Group.
   5. Condux International, Inc.
   6. ElecSys, Inc.
   7. Electri-Flex Company.
   8. IPEX Inc.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Manhattan/CDT; a division of Cable Design Technologies.
   11. Spiraduct/AFC Cable Systems, Inc.

B. Duct Accessories:
   1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
   2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.3 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 incheshorizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Building Structure: Use end bells, spaced approximately 10 incheso.c. for 5-inchducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feetfrom the end bell without reducing duct line slope and without forming a trap in the line.
   2. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psighydrostatic pressure.

F. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares.

G. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feetof duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inchesbetween tiers. Tie entire assembly together using non-metallic straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour.
      b. If more than one pour is necessary, terminate each pour in a stair step.
   3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces.
   4. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

5. Minimum Space between Ducts: 3 inchesbetween ducts and exterior envelope wall, 2 inchesbetween ducts for like services, and 4 inchesbetween power and signal ducts.
6. Depth: Install top of duct bank at least 24 inchesbelow finished grade in areas not subject to deliberate traffic, and at least 30 inchesbelow finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
7. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inchesof concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inchesfrom edge of base. Install insulated grounding bushings on terminations at equipment.
8. Warning Tape: Bury warning tape approximately 12 inchesabove all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inchesof the centerline of duct bank. Provide an additional warning tape for each 12-inchincrement of duct-bank width over a nominal 18 inchesSpace additional tapes 12 inchesapart, horizontally.

H. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feetof duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inchesbetween tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inchesin nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inchesover ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inchesbetween ducts for like services and 6 inchesbetween power and signal ducts.
7. Depth: Install top of duct bank at least 36 inchesbelow finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inchesof concrete.
   b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inchesfrom edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.4 GROUNDING

A. Ground underground ducts according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts.
   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.6 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260543_UNDERGROUND DUCTS AND RACEWAYS.DOC

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Identification for raceways and metal-clad cable.
   2. Identification of power and control cables.
   3. Underground-line warning tape.
   4. Warning labels and signs.
   5. Instruction signs.
   6. Equipment identification labels.
   7. Miscellaneous identification products.

B. Division 27 Section "Telecommunication Cabling Systems" for cabling identification products.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Colors for Raceways Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage.

B. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch-thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around a group of conductors.

D. Metal Tags: Brass or aluminum, 2-inch by 2-inch by 0.05-inch, with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 3 inches wide by 4 mils thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. ¼-inch grommets in corners for mounting. Nominal size, 7 inches by 10 inches.

C. Metal-Backed, Butyrate Warning Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal size, 10 by 14 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR PER NEC."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label. Secure label with stainless steel screws.

B. Engraved, Laminated Acrylic or Melamine Label: White letters on a dark-gray background. Minimum letter height shall be 3/8 inch. Secure label with stainless steel screws.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-insert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum width: 3/16 inch
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F
4. Color: Black, except where used for color-coding.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-clad cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with orange paint at regular intervals.

B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with paint color as identified below, at regular intervals:
1. Fire Alarm System: Red
2. Fire Suppression Supervisory and Control System: Red and yellow

C. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Install underground-line warning tape for both direct-buried cables and cables in raceway and concrete-encased ductbanks.

E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.

F. Instruction Signs:
   1. Operating Instruction signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
   2. Emergency Operation Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Equipment to Be Labeled:
      a. Panelboards
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Switchboards.
      e. Transformers.
      f. Disconnect Switches.
      g. Enclosed circuit breakers.
      h. Enclosed controllers.
      i. Push-button stations.
      j. Power transfer equipment.
      k. Contactors.
      l. Engine-generator.
      m. Fire alarm control panels and annunciators.
      n. Photovoltaic Inverters and disconnects.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. System Identification Painted Color-Coding for Raceways and Cables: Identify at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Color-Coding for Phase and Voltage Level, Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
   1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
   3. Colors for 480/277-V Circuits:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.

G. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

END OF SECTION 260553

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260553_IDENTIFICATION FOR ELECTRICAL SYSTEMS.DOC

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based fault-current, overcurrent protective device coordination, and arc flash hazard studies. Protective devices shall be set based on results of the protective device coordination study.

B. The studies shall be submitted to the Design Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

C. Overcurrent protective devices in distribution equipment associated with Article 700 of NFPA 70 are required to be selectively coordinated. The coordination study must include confirmation that equipment provided serving those systems are selectively coordinated in accordance with NFPA 70.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.
   4. Short Circuit Report.
   5. Arc Flash Analysis Report

E. Studies shall include the following outline:
   1. Table of Contents
   2. Executive Summary
   3. Calculation methods and tabulations.
   4. System input Data
   5. One-line diagrams and impedance diagrams.
   6. Results of the study.
   7. Conclusions and recommendations.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Motor horsepower and code letter designation according to NEMA MG 1.
   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
      c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
      d. Generator thermal-damage curve.
      e. Ratings, types, and settings of utility company's overcurrent protective devices.
      f. Special overcurrent protective device settings or types stipulated by utility company.
      g. Time-current-characteristic curves of devices indicated to be coordinated.
      h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
      i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
      j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Switchboard.
   2. Branch circuit panelboard.

B. Study electrical distribution system from normal and emergency power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10.
      b. ANSI C57.12.22.
      c. ANSI C57.12.40.
      d. IEEE C57.12.00.
      e. IEEE C57.96.
   2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
   3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
   1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
   1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
   2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
   3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag.
      b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
      c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
      d. Fuse-current rating and type.
      e. Ground-fault relay-pickup and time-delay settings.
   2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
      a. Device tag.
      b. Voltage and current ratio for curves.
      c. Three-phase and single-phase damage points for each transformer.
      d. No damage, melting, and clearing curves for fuses.
      e. Cable damage curves.
      f. Transformer inrush points.
      g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH STUDY

A. Provide an electrical arc flash hazard analysis on the building to determine incident energy, arc flash protection boundaries, and required personal protection equipment (PPE) for all electrical equipment in the facility. The calculations shall comply with NFPA-70E 2004, and IEEE-1584-2002. Labels shall also be provided for equipment as outlined

B. The purpose of this study is to provide a comprehensive software model of the building's electrical distribution system, which will document compliance with NFPA 70E mandates as described below.

C. The analysis and procedures shall comply with the following standards and recommended practices for power system studies.
   1. NFPA-70E, 2004 Standard for Electrical Safety in the Workplace
   2. IEEE-1584-2002
   3. IEEE-242 "Buff Book" Protection and Coordination of Industrial Power Systems
   4. IEEE-399 "Brown Book" Power System Analysis

D. Method
   1. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical system studied. The calculations shall comply with NFPA-70E 2004, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E, and to

provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Article 130.1(A) (2) for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.

2. The arc flash study shall determine the following results. The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:
    a. Equipment name and voltage.
    b. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
    c. Equipment type, i.e. switchgear, Panel, VFD, etc.
    d. Equipment arc gap.
    e. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
    f. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
    g. Worst-case arc flash boundary for each bus/equipment in the model.
    h. Worst-case arc flash hazard incident energy in cal/cm2 for each bus/equipment in the model.
    i. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.
    j. Working distances for up to five different distances showing items worst-case arc flash boundary, worst-case arc flash hazard incident energy, and worst-case personal protective equipment (PPE) for each distance.
    k. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm2 and provide recommendations to reduced arc flash energy levels for these areas.
3. Flag results where 85% arcing current provided worst-case results.
4. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.

E. Provide a detailed arc flash analysis report including as a minimum:
    1. Introduction.
    2. Methodology.
    3. Information Sources.
    4. Key Assumptions.
    5. Arc Energy at 100% and reduced currents.
    6. IEEE 1584-2002 Considerations.
    7. Explanation of Data in Arc Flash Hazard Report Tables.
    8. NFPA 70E Information.
    9. Shock Hazards with covers removed.
    10. Shock Hazard Approach Boundaries.
    11. Limited Approach Boundary.
    12. Restricted Approach Boundary.
    13. Prohibited Approach Boundary.
    14. Arc Flash Hazard Boundaries.
    15. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
        a. Working distances.
        b. Energy Levels.
        c. PPE Requirements.

d. Recommendations to reduce arc flash hazard energy and exposure.
e. Arc Flash Hazard Report.
f. Electronic Copy in Adobe Acrobat format (6.0 or later)

3.6 ADJUSTMENTS, SETTINGS AND MODIFICATIONS

A. Provide necessary field settings, adjustments, minor modifications, for conformance with the study, without any additional cost to owner. Examples of minor modifications would be trip sizes within the same frame, the time curve characteristics of inductions relays, CT ranges, etc.

B. Proposed corrective modifications will be taken under advisement and the Construction Manager will be given further instructions.

END OF SECTION 260573

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260573_OVERCURRENT PROTECTIVE DEVICE COORD STUDY.DOC

SECTION 260800 ELECTRICAL SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment Start-Up and Functional Performance Testing.

B. Validation of proper and thorough installation of Division 26 systems and equipment.

C. Generic Start-Up Documentation for electrical systems and equipment.

D. Development of final Start-Up Documentation for electrical systems and equipment.

E. System Start-Up and Turn-Over procedures.

F. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

A. Commissioning (Commissioning) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section outlines the Cx procedures specific to the Division 26 Contractors. Requirements common to all Sections are specified in Sections n 019113 and 019114 This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

1.3 SCOPE

A. The following systems and equipment are included in the Scope of Commissioning for this project:

B. Electrical Systems: All 26 Electrical equipment and systems are subject to commissioning, including but not limited to the systems listed below. All components and devices that make up these systems are included.

1. Grounding Equipment and Building Grounding System
2. Switchboard
3. Circuit Breakers
4. Distribution Dry-Type Transformers
5. Distribution and Branch Circuit Panelboards
6. Automatic Transfer Switches
7. Emergency Power Generators and Distribution Systems

8. Feeders and Large Branch Circuits
9. Lighting Controls
10. Lightning Protection System

1.4 RELATED WORK AND DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. The Cx process references many related Sections, particularly Section 019113 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 019113.

C. Refer to Section 019113 for a complete list of Sections on Related Work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

A. National Electric Code (NEC)

B. American Society for Testing and Materials (ASTM)

C. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

D. Illuminating Engineering Society (IES)

E. Institute of Electrical and Electronics Engineers (IEEE)

F. International Electrical Testing Association (NETA)

G. National Electrical Manufacturers Associates (NEMA)

H. National Fire Protection Association (NFPA)

I. Underwriters Laboratory, Inc. (UL)

J. Refer to Section 019113 for additional Reference Standards.

1.7 DOCUMENTATION

A. Documentation shall be as required in Section n 019113. In addition, Contractor shall also provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Short Circuit and Coordination Study: CA shall review and recommend approval.
2. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports shall be provided in PDF electronic format.
3. Field Testing Agency Reports: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format. These may include but are not limited to:

a. Electrical Testing Agency Reports
b. Thermographic Survey Report
c. Generator Load Testing

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 26.

B. Construction Phase

1. Provide skilled technicians qualified to perform the work required.
2. Provide factory-trained and authorized technicians where required by the Contract Documents.
3. Prepare and submit required draft Start-Up Documentation and submit along with the manufacturer's application, installation and start-up information.
4. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
6. Start-Up, Adjust, Test, and Turn-Over systems and equipment prior to functional performance testing by the CA. Approved Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
7. Record Start-Up on approved Start-Up Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above and in Section 019113. Each task or item shall be indicated with the Party actually performing the task or procedure.
8. Coordinate the work of the Electrical Testing Agency and the Cx requirements.

C. Acceptance Phase

1. Assist CA in Functional Performance Testing. Assistance will typically include the following:
2. Manipulate systems and equipment to facilitate Functional Performance Testing (as specified in Section 019113, Section 019114, and the Cx Plan; in some cases this will entail only an initial sample);
3. Provide any specialized instrumentation necessary for Functional Performance Testing;

1.9 INDEPENDENT ELECTRICAL TESTING AGENCY

A. An Independent Electrical Testing Agency shall be provided under the construction specifications and therefore included with the bid. Many of the aspects of the Start-Up and Functional Performance Testing indicated herein will be accomplished under the respective section and witnessed by the CA at the indicated sample rate. CA will include applicable test results in the functional performance testing record.

1. Fire Pump Controller and Transfer Switch operation testing documentation shall be included.

1.10 FPT ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in Section 019114 and in the specification Sections applicable to the systems being tested. Unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device, which shall typically conform to NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-1991.

1.11 TRAINING

A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. Unless otherwise noted, all equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Testing Instrumentation: Contractor shall provide all instrumentation necessary for tests for which they are responsible. CA will provide standard instrumentation for measuring medium and low voltage electrical voltage, current, power factor, power, and total harmonic distortion (THD). CA will provide receptacle testers for normal and GFI receptacle tests. Contractor shall provide all other instrumentation required to accomplish the specified testing.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines 'generic' or minimally acceptable Start-Up Documentation (which are defined to include both 'Start-Up Checks' and 'Start-Up Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor

development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 019113 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.

3.2 START-UP CHECKS COMMON TO ALL SYSTEMS

A. The following Start-Up verifications and procedures shall be considered common to all systems:

1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
2. Verify labeling is affixed per specification and visible.
3. Verify prerequisite procedures are done.
4. Inspect for damage and ensure none is present.
5. Verify system is installed per the manufacturer's recommendations.
6. Verify system has undergone Start-Up per the manufacturer's recommendations.
7. Verify that access is provided for inspection, operation and repair.
8. Verify that access is provided for eventual replacement of the equipment.
9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
10. Verify all gauges and test ports are provided as required by contract documents and manufacturer's recommendations.
11. Verify all recorded nameplate data is accurate.
12. Verify that the installation ensures safe operation and maintenance.
13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
14. Verify all rotating and moving parts are properly lubricated.
15. Verify all monitoring and ensure all alarms are active and set per Owner's requirements.
16. Complete all nameplate data and confirm that ratings conform to the design documents.

3.3 GROUNDING/BUILDING GROUNDING SYSTEM

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Conduct fall of potential ground resistance tests per IEEE Standard 81 at each test well and at service equipment.

D. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3.4 SWITCHBOARDS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a Factory-Trained Manufacturer’s Representative to assist the Contractor in the installation and start-up service of the equipment for a period of 3 working days in 3 visits and train Owner's maintenance personnel as specified below. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.

1. Visual and Mechanical Inspections listed in NETA 7.1.1.
2. Check calibration/setting of trip devices using system coordination study.
3. Verify calibration/setting of digital metering.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.

1. Visually and mechanically inspect to include the following: anchoring; grounding; torque of feeder and incoming bus duct connections; feeder cable and integral main bus connections; switchgear section alignments; electrical clearances; mechanical operation of breaker/fuse drawout elements and operating mechanisms, manual trip function; main bus safety shutters; and installation verification using manufacturer's checklist.
2. Electrical tests listed in NETA 7.1.2. Optional tests are not required.
3. Test each breaker in accordance with the Circuit Breaker tests listed in this Section.
4. Conduct operational/functional tests of protective relaying. Time-current tests shall be conducted and trip points shall be set per the Short Circuit and Coordination Study.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.5 CIRCUIT BREAKERS

A. Include all applicable ‘Start-Up Checks Common to All Systems”. Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a manufacturer-certified specialist to supervise the installation, make adjustments, and perform tests on the insulated case breakers, power breakers and medium-voltage breakers and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer’s instructions.

1. Visual and Mechanical Inspections listed in NETA 7.6.1.1.1 insulated case and molded case breakers, NETA 7.6.1.2.1 for low-voltage power breakers, and NETA 7.6.1.3.1 for medium-voltage air breakers.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer’s instructions.

1. Electrical tests listed in NETA 7.6.1.1.2 insulated case and molded case breakers, NETA 7.6.1.2.2 for low-voltage power breakers, and NETA 7.6.1.3.2 for medium-voltage air breakers. Optional tests are not required.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.6 DISTRIBUTION DRY-TYPE TRANSFORMERS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.

1. Inspect wiring connections.
2. Insure taps are adjusted.
3. Inspect grounding.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Visually and mechanically inspect to include the following: mounting, grounding, electrical clearances, and K-factor and/or isolating transformers are installed where required.
2. Perform insulation resistance, turns ratios, and polarity tests on each type /size of transformer.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to troubleshooting, servicing, and preventative maintenance.

3.7 DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.

1. Visually and mechanically inspect to include the following: mounting, separate ground and neutral connections per circuit, completed circuit directories, electrical clearances, KAIC ratings of panelboard and breakers.
2. Inspect wiring connections.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Correct surge suppression devices installed.
2. Conduct insulation resistance tests.

3. Correct identification and phasing arrangements.
4. Verify that branch circuit labeling on a minimum of 10% of the panelboard branch circuits matches the printed panelboard directory. If 25% or more of the tested branch circuits do not match the printed directory, verify another 10% of the panelboard branch circuits. If 25%, or more, of these branch circuits do not match the printed directory, verify 100% of the panelboard branch circuits.

3.8 AUTOMATIC TRANSFER SWITCHES (ATS)

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a manufacturer-certified specialist to supervise the installation, make adjustments, perform tests on the automatic transfer switches, and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.

1. Visually inspect the systems.
2. Ensure the terminations are tight and all ancillary equipment completely installed.
3. Ensure all overloads are in place.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Electrical tests listed in NETA 7.22.3.2.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

3.9 EMERGENCY POWER ENGINE GENERATORS AND DISTRIBUTION SYSTEMS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a manufacturer-certified specialist to supervise the installation, make adjustments, and perform tests on the engine generators and emergency power switchgear and train Owner's maintenance personnel. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.

1. Visually inspect the systems.
2. Ensure the terminations are tight on power and control wiring.
3. Verify all ancillary equipment completely installed.
4. Ensure all overloads are in place.
5. Verify that generator is set in place.
6. Verify fuel connections.
7. Verify radiator connections.

8. Verify battery connection.
9. Verify exhaust connections.
10. Verify block or oil heater connection.
11. Check and record engine oil level, radiator water level, and battery electrolyte level.
12. Piping System Tests: Complete system test in accordance with the respective section.
13. Inspect the installation and access/clearance for service and maintenance to ensure it meets the project and manufacturer's requirements.
14. Check lubricating oil for lubricated-type equipment.
15. Check for proper seismic restraints.
16. Check that safety valves have correct setting; greater than compressor discharge pressure, but not greater than pressure rating of system components.
17. Check that all operating controls are set for initial safe operation.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Test generator at 50%, 75%, and 100% load capacity using load banks at 100% power factor.
2. Run load test at all loads for 30 minutes recording engine and alternator readings at the start, at 15 minutes and at 30 minutes.
3. Simulate operation of all generator safeties such as high oil pressure, low oil pressure, high temperature, over speed, etc. Observe function of safeties under actual malfunction situation.
4. Check for excessive vibration and noise. Correct problems.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

3.10 FEEDERS AND LARGE BRANCH CIRCUITS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: This paragraph and subparagraphs apply to all feeders serving panelboards, and motor control centers, all conductors connected to switchgear and switchboards, and all circuits that are rated for 100 amps, or larger. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.

1. Inspect cable support and terminations.
2. Verify equipment edges are not in contact with cables or that protective padding is provided.
3. Visually and mechanically inspect to include the following: large junction and pull boxes, supports of raceways and cable bus, and compression type terminations.
4. Torque test terminations and verify they are in accordance with manufacturers recommendations.
5. Correct identification and phasing arrangements.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Verify cable size and ratings match single-line diagram. Verify correct overcurrent protection.
2. Torque test terminations and verify they are in accordance with manufacturers recommendations.
3. Correct identification and phasing arrangements.

4. Conduct continuity test of each feeder.
5. Conduct insulation resistance test on each cable with respect to ground and adjacent cables.

3.11 LIGHTING CONTROLS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.

1. Ensure all labeling for all relays/contactors is affixed and accurate.
2. Ensure all terminations are tight.
3. Check sensor placement is adequate for required duty.
4. Ensure adequate access is provided to all relays/contactors, timeclocks, etc.
5. Ensure all circuits for the loads are energized and ready for testing.
6. Obtain all time schedules and individual device time-delay settings for all spaces from the Owner.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Test, calibrate, and set all sensing (photocells, motion sensors, etc.) devices.
2. Verify the correct operation of all control devices (contactors, relays, timeclocks, BAS interface relays, etc.).
3. Check full load current on all breakers serving controlled lighting to ensure that the breaker is properly sized.
4. Check full load current on all control device contacts serving controlled lighting to ensure that the contact rating is properly sized.
5. Enter all time schedules per Owner's direction. Individual device time-delay settings are handled as part of the Room/Zone Checkout described in this Section.
6. Validate all interfaces with other systems on a point-by-point basis.

E. Training: Train Owner's maintenance personnel on the operation, programming and maintenance of the lighting controls.

3.12 INTEGRATED LIGHTING CONTROL SYSTEMS

A. Include all applicable 'Start-Up Checks Common to All Systems". Additional Start-Up Checks and Tests are as follows.

B. General: Provide the services of a factory-trained manufacturer's representative to assist the Contractor in the installation and start-up service of the lighting control system and train Owner's maintenance personnel as specified below. Representative will confirm the proper installation and operation of all system components. Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checks and Tests used for this project.

C. Start-Up Checks: During start-up, perform the following checks and any additional checks specified in manufacturer's instructions.

1. Ensure all labeling is affixed and accurate.
2. Ensure all terminations are tight.
3. Check sensor placement is adequate for required duty.
4. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
5. Ensure all circuits for the loads are energized and ready for testing.
6. Obtain all time schedules, individual device time-delay settings for all spaces, and on/off fade-rate settings from the Owner.

D. Start-Up Tests: During start-up, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Test, calibrate, and set all digital and analog sensing, and actuating devices. Calibrate each instrumentation device by making a comparison between the graphic display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the Start-Up Report.
2. Check each digital control point by making a comparison between the control command at the control panel and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device in the BAS Start-Up Report.
3. Check full load current on all breakers serving controlled lighting to ensure that the breaker is properly sized.
4. Check full load current on all control device contacts serving controlled lighting to ensure that the contact rating is properly sized.
5. Enter all time schedules, override time-delays and on/off fade rates per Owner's direction.
6. For Operator Interfaces:

    a. Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
    b. Output all specified reports for review and approval.
    c. Verify the alarm printing and logging is functional and per requirements.

7. Validate all interfaces with other systems on a point-by-point basis.

E. Training: Train Owner's maintenance personnel on the operation and programming of the lighting control system.

3.13 LIGHTNING PROTECTION SYSTEM

A. General: Refer to the quality control requirements listed in applicable sections of Division 26 for additional checks and tests. These shall be included in the Start-Up Checklists and Tests used for this project.

B. Start-Up Tests: During startup, perform the following tests, measurements, or procedures and any additional tests, measurements, or procedures specified in manufacturer's instructions.

1. Review UL test certification.
2. Check for receipt of UL master label.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Refer to division 26 section "Electrical System Commissioning" for scope of commissioning requirements.

1.2 SUMMARY

A. Section Includes:
1. Photoelectric switches.
2. Indoor occupancy sensors.
3. Lighting contactors.
4. Lighting Relay panel.
5. Indoor daylighting sensors.
6. Emergency Lighting control units.

B. Related Requirements:
1. Section 262726 "Wiring Devices" for wall-box dimmers, and manual light switches.
2. Division 01 for Lighting Control Commissioning requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. NSi Industries LLC; TORK Products.
4. Tyco Electronics; ALR Brand.
5. Lutron Electronics, Inc.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
6. Photocontrol must withstand temperatures of minus 40° F to 140° F.

2.2 INDOOR OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Building Automation, Inc or comparable product by one of the following:
1. Leviton Mfg. Company Inc.
2. Sensor Switch, Inc.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes. Sensor shall be compatible with all lamp and ballast combinations.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

9. Isolated relay for connection to building automation system.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Building Automation, Inc or comparable product by one of the following:
   1. Leviton Mfg. Company Inc.
   2. Sensor Switch, Inc.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
   3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1800-VA fluorescent at 277 V.

C. Wall-Switch Sensor Tag S1:
   1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 1000 sq. ft..
   2. Sensing Technology: Ultrasonic and passive infrared. (dual technology)
   3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
   4. Voltage: Match the circuit voltage; type.
   5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
   6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
   7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
   8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
   9. Device and faceplate shall be with in color.

D. Wall-Switch Sensor Tag S2:
   1. Standard Range: 180-degree field of view, with a minimum coverage area of 1000 sq. ft..
   2. Sensing Technology: Dual technology- PIR and Ultrasonic.
   3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
   4. Voltage: Match the circuit voltage; type.
   5. 2 relays for dual level switching
   6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
   7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
   8. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
   9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
   10. Isolated relay for use with Building Management System.
   11. Device and faceplate shall be white in color.

2.4 CEILING OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings Hubbell Building Automation, Inc or comparable product by one of the following:

1. Leviton Mfg. Company, Inc.
2. Sensor Switch, Inc.

B. Dual Technology Type: Ceiling mounting; detect occupancy by using ultrasonic and passive infrared detection methods in area of coverage. Particular technology that controls on-off functions shall be selectable in the field by operating controls on unit. Device and faceplate shall be white in color.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage: Detect occupancy anywhere within a circular area of 2000 sq. ft..
4. Isolated relay to interface with Building Management System.

C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.5 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Corporation.
4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
5. Square D; a brand of Schneider Electric.

B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
1. Monitoring: On-off status.
2. Control: On-off operation.

2.6 LIGHTING RELAY PANELS

A. Manufactures: Subject to compliance with requirements provide products by the following:
1. Lighting Control and Design.
2. Leviton Mfg. Company Inc.

B. Description: Digital lighting relay panel in NEMA1 enclosure with hinged locking door with normally closed, zero cross, 20 amp, 277volt relays to serve corridor lighting and exterior site lighting circuits.

C. BAS Interface: Provide hardware interface to enable the BAS to control lighting loads.

2.7 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Mfg. Company Inc.
4. Sensor Switch, Inc.
5. Watt Stopper.

B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 277-V ac, for-A tungsten at 120-V ac.
5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching

2.8 EMERGENCY LIGHTING CONTROL UNIT

A. Provide UL listed emergency lighting control unit to allow control of emergency lighting within classrooms and labs which have overhead projection. Philips bodine# BLCD-20B

2.9 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 22 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260923 FL - LIGHTING CONTROL DEVICES.DOC

SECTION 260933 - CENTRAL DIMMING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Refer to Division 26 Section “Electrical System Commissioning” for scope of commissioning requirements.

1.2 SUMMARY

A. Section includes microprocessor-based central dimming controls with the following components:

1. Digital control network.
2. Master-control stations.
3. Wall stations.
4. Dimmer cabinets.
5. Manual switches and plates for controlling dimmers.
6. Switching cabinets.

B. Related sections include the following:

1. Division 26 section "Lighting Control Devices" for photoelectric switches and occupancy sensors.
2. Division 26 section "Wiring Devices" for toggle switches and wall dimmer sliders.
3. Division 26 section "Electrical System Commissioning" for commissioning requirements.

1.3 DEFINITIONS

A. Fade Override: The ability to temporarily set fade times to zero for all lighting scenes.

B. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.

C. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.

D. Low Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.

E. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.

F. SCR: Silicon-controlled rectifier.

G. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For central dimming and switching controls; include elevation, features, characteristics, and labels.
2. For dimmer and switching panels; include dimensions, features, dimmer characteristics, ratings, and directories.
3. Device plates, plate color, and material.
4. Ballasts and lamp combinations compatible with dimmer controls.
5. Sound data including results of operational tests of central dimming controls.
6. Operational documentation for software and firmware.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Sequence of operation to describe how each area is controlled.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For central dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Software manuals.
b. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
c. Operation of adjustable zone controls.
d. Testing and adjusting emergency power features.

1.6 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of central dimming controls that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Lutron Electronics Co, Inc. Grafik Eye System for large meeting rooms and lobby lighting. Lutron Quantum system for Atrium lighting.

2.2 GENERAL SYSTEM REQUIREMENTS

A. Compatibility:

1. Dimming control components shall be compatible with lighting fixtures, ballasts, drivers and transformers.
2. Dimming control devices shall be compatible with lighting control system components specified in and in Section 260923 "Lighting Control Devices."

B. Dimmers and Dimmer Modules: Comply with UL 508.

1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

2.3 SYSTEM DESCRIPTION

A. Description: Microprocessor-based, solid-state controls consisting of control stations and a separately mounted dimmer cabinet.

1. Operation: Change variable dimmer and switching settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
2. System control shall include master wall stations, dimmer panels, and switching panels.
3. Each zone shall be configurable to control the following light sources:

a. Fluorescent lamps with electronic ballasts.
b. Line-voltage Tungsten Halogen lamps.
c. Low-voltage Tungsten Halogen lamps.
d. Non-dimmed loads.
e. Fluorescent lamps with digitally addressable ballasts.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

2.4 CONTROL NETWORK

A. Dimmers and switching relays shall receive signals from control stations that are linked to dimming and switching cabinets with a common network data cable.

B. Functions of network control stations shall be set up at master station that include the number and arrangement of scene presets, zones, and fade times at wall stations.

1. Control Voltage: 24-V dc.

2.5 DIMMING AND SWITCHING CABINETS

A. Factory wired, convection cooled without fans and suitable to control designated lighting equipment or accessory functions.

B. Ambient Conditions:

1. Temperature: 60 to 95 deg F.
2. Relative Humidity: 10 to 90 percent, noncondensing.
3. Filtered air supply.

C. Dimmer Cabinet Assembly: NRTL listed and labeled.

D. Cabinet Type: Plug in, modular, and accepting dimmers of each specified type in any plug-in position.

1. Integrated Fault-Current Rating: 10,000-A RMS symmetrical.

E. Lighting Dimmers: Solid-state SCR dimmers.

1. Primary Protection: Magnetic or thermal-magnetic circuit breaker, also serving as the disconnecting means.
2. Dimmer response to control signal shall follow the "Square Law Dimming Curve" specified in IESNA's "IESNA Lighting Handbook."
3. Dimming Range: 0 to 100 percent, full output voltage not less than 98 percent of line voltage.
4. Dimmed circuits shall be filtered to provide a minimum 350-mic.sec. current-rise time at a 90-degree conduction angle and 50 percent of rated dimmer capacity. Rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load-current waveform.

F. Non-dim modules shall include relays with contacts rated to switch 20-A tungsten-filament load at 120-V ac and 20-A electronic ballast load at 277-V ac.

G. Accessory function control modules shall be compatible with requirement of the accessory being controlled.

H. Digital Control Network:

1. Dimmers shall receive digital signals from digital network control stations that are linked to the dimmer cabinet with a common network data cable.
2. Functions of digital network control stations shall be set up at the dimmer cabinet's electronic controls that include indicated number and arrangement of scene presets, channels, and fade times.

I. Emergency Power Transfer Switch: Comply with UL 1008; factory prewired and pretested to automatically transfer load circuits from normal to emergency power supply when normal supply fails.

1. Transfer from normal to emergency supply when normal-supply voltage drops to 55 percent or less.
2. Retransfer immediately to normal on failure of emergency supply and after an adjustable time-delay of 10 to 90 seconds on restoration of normal supply while emergency supply is available.
3. Integrated Fault-Current Rating: Same value as listed for the panel.

2.6 MANUAL SWITCHES AND PLATES

A. Switches: Modular, momentary push-button, low-voltage type.

1. Color: White unless otherwise indicated; red when associated with emergency circuits.
2. Integral Pilot Light: Indicate when circuit is on. Use where indicated.
3. Locator Light: Internal illumination.
4. Wall Plates: Comply with requirements in Section 262726 "Wiring Devices" for materials, finish, and color. Use multigang plates if more than one switch is indicated at a location.
5. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.7 FLUORESCENT ELECTRONIC DIMMING BALLASTS

A. General
1. Ten-year operational life while operating with a case temperature range of 10 degrees C (50 degrees F) to 75 degrees C (167 degrees F) and 90 percent non-condensing relative humidity.
2. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.
3. Electrolytic capacitors to operate at least 20 degrees C below the capacitor's maximum temperature rating when the ballast is under fully-loaded conditions and case temperature is 75 degrees C (167 degrees F).
4. Programmed Rapid Start Type.
5. Maximum inrush current of 3 amperes for 277V ballasts.
6. Current crest factor (CCF) less than 1.7.
7. Meet ANSI C82.11 High frequency ballast standard.
8. Will not interfere with infrared devices operating at frequencies between 38 kHz and 42 kHz.
9. Withstand up to a 6,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
10. Manufactured in a facility that employ ESD reduction practices in compliance with ANSI/ESD S20.20.
11. Inaudible in a 27 dBA ambient.
12. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
13. Total Harmonic Distortion less than 10 percent and meet ANSI C82.11 maximum allowable THD requirements
14. Ballasts to track evenly across:
    a. Multiple lamp lengths.
    b. All light levels.

B. Digital Control
1. Product: 1% Digitally Addressable Dimming Ballasts
2. Continuous dimming from 100 percent to 1 percent relative light output.
3. Monitor and report lamp and ballast status.
4. Lights automatically return to the setting prior to power interruption.
5. Unique internal reference number visibly displayed on ballast cover.

2.8 DIGITAL Lighting Control Module

A. Digital Fixture Lighting Control Module
1. Mechanical:
    a. Listed to UL 508 as industrial control equipment.

b. Delivered and installed as a UL listed factory assembled panel.
c. Panels passively cooled via free-convection, unaided by fans or other means.

2. Supports one or two independent links of up to 64 addressable ballasts per link.
3. Connect without interface to wired:
   a. Daylight sensors
   b. Wall stations
4. Connects to Lighting Management Panels via RS485.
5. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
6. Thermal protection reports to Light Management System if module overheats.
7. Contact Closure Input
   a. Directly accept contact closure input from a dry contact closure or solid-state output without interface to:
      1) Activate afterhours mode
      2) Provide basic load shed functionality
8. Emergency Contact Closure Input
   a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface.
   b. Disable control operation until emergency signal is cleared.
9. Programming Connection:
   a. Provide Ethernet input for wired connection to wireless router.
   b. Provide ability for programming from an iPod touch or IPhone via wireless router.

2.9 LIGHTING MANAGEMENT PANEL

A. Provide Lighting Management Panel in a pre-assembled NEMA listed enclosure with terminal blocks listed for field wiring.

B. Enables Light Management software to control and monitor Digitally Addressable dimming ballasts, and low voltage skylight window treatments.
   1. Lighting Management Panel utilizes Ethernet connectivity to management software.
      a. Dedicated Network Environment is used to connect Q-Manager with Lighting Management Panels.

C. Integrate control station devices, power panels, shades, preset lighting controls, and external inputs into single customizable, multiple failsafe lighting control system, operable manually, automatically or through computer control.

D. Astronomical time clock.

E. Maintains a backup of the programming in a non-volatile memory capable of lasting more than ten years without power.

2.10 Light Management System Computer

A. Server
   1. Used for 24 hour per day, 7 day per week programming, monitoring, control, graphics, and data logging of digital network lighting controls.

2. Used to handle client machine request in multi-computer systems.
3. Computer to be provided by the lighting control system manufacturer.
4. Computer software preinstalled and tested prior to shipping.

2.11 Lighting Management System Software

A. Provide system software license and hardware that is designed, tested, manufactured, and warranted by a single manufacturer.

B. Configuration Setup
   1. Used to make system programming and configuration changes
   2. Windows based, capable of running on either central server or a remote client over TCP/IP connection
   3. Allow user to:
      a. Capture system design.
         1) Geographical Layout
         2) Load Schedule Zoning
         3) Shade Grouping
         4) Equipment Schedule
         5) Equipment assignment to lighting management panels
         6) Daylighting design
      b. Define the configuration for the following in each area:
         1) Lighting Scenes
         2) Control Station Devices
         3) Interface and Integration Equipment
         4) Occupancy/After Hours
         5) Daylighting
         6) Emergency Lighting
      c. Start-up
         1) Addressing
         2) Daylighting

C. Control and Monitor
   1. Graphical Floorplan View
      a. The system navigation and status reporting is performed using customized CAD based drawings of your building. Pan and Zoom feature allows for easy navigation. Basic system view is always available.
   2. Control of Atrium Lights
      a. Area lights can be monitored for on/off status.
      b. All lights in an area can be turned on/off or sent to a specific level.
      c. For areas that have been zoned, these areas may be sent to a predefined lighting scene, and individual zones may be controlled.
      d. Area lighting scenes can be modified in real-time, changing the levels zones go to when a scene is activated.
      e. Area skylight shades can be monitored for current preset or position.
      f. Area skylight shades can be opened/closed, sent to a preset, or sent to a specific position.
   3. Daylighting

a. Daylighting can be enabled/disabled. This can be used to override the control currently taking place in the space.
b. Daylight target levels can be changed for each daylit area. This is particularly useful when new departments move into a space.

4. Scheduling
   a. Schedule time of day and astronomic timeclock events to automate functions for lights and shades.
5. Reporting allow the building manager to gather real-time and historical information about the system as follows:
   a. Energy Reports – Show a comparison of cumulative energy used over a period of time for one or more areas.
   b. Power Reports – Show power usage trend over a period of time for one or more areas.
   c. Lamp Failure Report – Shows which areas are currently reporting lamp failures.
6. Diagnostics
   a. Diagnostics allows the building manager to check on the status of all equipment in the lighting control system. Devices will be listed with a reporting status of OK, missing, or unknown.

2.12 LOW-VOLTAGE WALL STATIONS

A. System Wall Stations
   1. Allows controls of any devices part of the Digital Network Lighting Control System. (Skylight Shade drives and Digital ballasts)
   2. Product: Preset Lighting and Shade Controls with Zone Override.
   3. Electronics:
      a. Use RS485 wiring for low voltage communication.
   4. Functionality:
      a. Upon button press, LEDs to immediately illuminate.
      b. LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or the LEDs turn off if the button press was not processed.
      c. Allow for easy reprogramming without replacing unit.
      d. Replacement of units does not require reprogramming.
   5. Color:
      a. Match NEMA WD1, Section 2 White.
   6. Provide faceplates with concealed mounting hardware.
   7. Engrave wall stations in English with appropriate button, zone, and scene engraving descriptions.
   8. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
   9. Software Configuration:
      a. Customizable control station device button functionality:
         1) Buttons can be programmed to perform single defined action.
         2) Buttons can be programmed to perform defined action on press and defined action on release.
   10. Control station device LEDs to support logic that defines when it is illuminated:
      a. Scene logic (logic is true when all zones are at defined levels).
      b. Room logic (logic is true when at least one zone is on).

c. Pathway (logic is true when at least one zone is on).
d. Last scene (logic is true when spaces are in defined scenes).

2.13 SENSORS

A. Interior Daylight Sensors
1. Wired daylight Sensor
a. Product: EC-DIR-WH
b. Use Class 2 wiring for low voltage communication
c. Can be replaced without reprogramming
d. Open-loop basis for daylight sensor control scheme
e. Stable output over temperature from 0º to 40º C
f. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection
g. Provide linear response from 0 to 500 foot-candles
h. Integral IR receiver for personal control
i. Constructed with plastic meeting UL94 HB
j. Mountable on lighting fixtures or recessed acoustical ceiling tiles
k. Constructed via sonic welding
l. Color:
1) Match NEMA WD1, Section 2 White.
m. Provide linear response from 0 to 10,000 foot-candles
n. Mounting:
1) Provide surface mounting bracket compatible with drywall ceilings.
2) Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
3) Provide temporary mounting means to allow technician to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method shall be designed for easy, damage-free removal.

B. Exterior Daylight Sensors
1. Calibrated with independent turn-on and turn-off thresholds; minimum 2 foot-candles difference between the turn-on and turn-off thresholds.
2. Enclosed in weatherproof housing with shading and lens protection visor.

2.14 ACCESSORIES

A. Emergency Lighting Interface
1. Provides total system listing to UL924 when used with lighting control system.
2. Senses all three phases of building power.
3. Provides an output to power panels or Digital Ballast Interfaces if power on any phase fails and sends all lights controlled by these devices to 100 percent intensity. Lights to return to their previous intensities when normal power is restored.
4. Accepts a contact closure input from a fire alarm control panel.

2.15 SOURCE QUALITY CONTROL

A. Perform full-function testing on all completed assemblies at end of line. Statistical sampling is not acceptable.

B. Perform full-function testing on 100 percent of all ballasts at the factory.

C. Audit burn-in at 40 degrees C (104 degrees F) ambient temperature of dimming assemblies and panels at full load for two hours.

D. Perform burn-in at 40 degrees C (104 degrees F) ambient temperature on 100 percent of all ballasts at the factory.

2.16 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Unshielded, Twisted-Pair Data Cable: Category 5e. Comply with requirements in Section 271500 "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer’s installation instructions.

B. Provide complete installation of system in accordance with Contract Documents.

C. Provide dedicated network between Q-Manager computer and Quantum Lighting Management Panels.

D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

E. Define each dimmer's/relay’s load type, assign each load to a zone, and set control functions.

F. Mount exterior daylight sensors to point due south with constant view of daylight.

G. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.

H. Season lamps at full intensity according to lamp manufacturer’s recommendation.

I. Lead lengths to lamp sockets not to exceed three feet for T5 linear fluorescent lamps.

J. Rapid starts sockets must meet IEC 60400

K. Systems Integration:
1. Equipment Integration Meeting Visit
a. Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures.

3.2 SERVICE AND SUPPORT

A. Startup and Programming
1. Provide factory certified field service engineer to make minimum of three site visits to ensure proper system installation and operation under following parameters
a. Qualifications for factory certified field service engineer:
1) Minimum experience of 2 years training in the electrical/electronic field.
2) Certified by the equipment manufacturer on the system installed.
b. Make first visit prior to installation of wiring. Review:
1) Low voltage wiring requirements.
2) Separation of power and low voltage/data wiring.
3) Wire labeling.
4) Lighting Management Panel locations and installations.
5) Control locations.
6) Computer jack locations.
7) Load circuit wiring.
8) Network wiring requirements.
9) Connections to other equipment and other Lutron equipment.
10) Installer responsibilities.
11) Power Panel locations.
c. Make second visit upon completion of installation of Network Lighting Control System:
1) Verify connection of power wiring and load circuits.
2) Verify connection and location of controls.
3) Energize Lighting Management Panels and download system data program.
4) Address devices.
5) Verify proper connection of panel links (low voltage/data) and address panel.
6) Download system panel data to dimming/switching panels
7) Check dimming panel load types and currents and supervise removal of by-pass jumpers.
8) Verify system operation control by control.
9) Verify proper operation of manufacturers interfacing equipment.
10) Verify proper operation of manufacturers supplied PC and installed programs.
11) Configure initial groupings of ballast for wall controls, daylight sensors and occupant sensors.
12) Initial calibration of sensors.
13) Obtain sign-off on system functions.
d. Make third visit to demonstrate and educate Owner's representative on system capabilities, operation and maintenance.
2. Startup
a. Q-Admin configuration
1) Naming and association of areas and lighting zones.

B. Training of customer representatives for Q-Admin.
1. Configuration Software used to make system programming and configuration changes
2. Control and Monitor
3. Green Glance

C. Tech Support
   1. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

3.3 FIELD QUALITY CONTROL

A. Manufacturer Services
   1. Aim and Focus Visit
      a. Facility Representative to coordinate on-site meeting with Lighting Control System Manufacturer and Lighting Design Consultant to make required lighting adjustments to the system for conformance with the Lighting Design Consultant's original design intent.

3.4 CLOSEOUT ACTIVITIES

A. Training Visit
   1. Lighting Control System Manufacturer to provide 1 day additional on-site system training to site personnel.

B. On-site Walkthrough
   1. Lighting Control System Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.

3.5 MAINTENANCE

A. Capable of providing on-site service support within 24 hours anywhere in continental United States and within 72 hours worldwide except where special visas are required.

B. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system startup.

END OF SECTION 260933

N:\N0912.00\DOC\SPEC\2012_03-16_BID\260933 FL - CENTRAL DIMMING CONTROLS.DOC

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

Installation of concrete bases are specified in section 260529, "Hangers and Supports for Electrical Systems".

B. Coordinate installation of structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ACME Electric Corporation; Power Distribution Products Division.
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. General Electric Company.
4. Siemens Energy & Automation, Inc.
5. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: Gray.

E. Taps for Transformers 15 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.

G. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

H. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

3. A minimum of k-4 shall be provided.

I. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.
   3. Shield Effectiveness:
      a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
      b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
      c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

J. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic nameplate for each distribution transformer. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Construct concrete bases according to manufacturer’s written instructions.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

N:\N0912.00\DOC\SPEC\2012_03-16_BID\262200_LOW VOLTAGE TRANSFORMERS.DOC

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Refer to Division 26 Section “Electrical System Commissioning” for scope of commissioning requirements.

1.2 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Surge Protection device.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.3 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

E. Submittal for switchboard shall not be submitted to engineer until the submittal and review of coordination study is complete.

F. Submit metering provisions with indication of approval by PEPCO.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Handle and prepare switchboards for installation according to NEMA PB2.1.

1.6 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

C. Indoor Enclosures: Steel, NEMA 250, Type 1.

D. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

E. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Assure that metering compartment complies with PEPCO requirements.

F. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

G. Hinged Front Panels: Allow access to metering, accessory, and blank compartments.

H. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
   2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   3. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
   4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   5. Neutral Buses: 100 percent of the ampacity of phase buses, equipped with mechanical connectors for outgoing circuit neutral cables.

I. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in or bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, third edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral circuit breaker disconnect.
4. Redundant suppression circuits.
5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
6. LED indicator lights for power and protection status.
7. Audible alarm, with silencing switch, to indicate when protection has failed.
8. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
9. Four-digit, transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.

D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277, three-phase, four-wire circuits shall be as follows:
1. Line to Neutral: 800 V for 480Y/277.
2. Line to Ground: 800 V for 480Y/277.
3. Neutral to Ground: 800 V for 480Y/277.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents. Series ratings are not acceptable.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.

4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long- and short-time time adjustments.
    c. Ground-fault pickup level, time delay, and I^2t response.
4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    a. Phase Currents, Each Phase: Plus or minus 1 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    d. Megawatts: Plus or minus 2 percent.
    e. Megavars: Plus or minus 2 percent.
    f. Power Factor: Plus or minus 2 percent.
    g. Frequency: Plus or minus 0.5 percent.
    h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
3. BAS Interface: Provide hardware interface for connection to division 23 building automation system.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.7 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Contractor to provide assistance to Division 23 Contractor. Necessary for fully functioning remote monitoring of customer meter.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
4. Perform the following infrared scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:
        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Switchboard will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

N:\N0912.00\DOC\SPEC\2012_03-16_BID\262413_SWITCHBOARDS.DOC

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Where Paragraphs of this Section conflict with similar paragraphs of the General and Supplementary Conditions and Division 1, requirements of this Section shall prevail.

1.2 SUMMARY

A. Provide all labor, materials and equipment to furnish and install all of the items specified herein, indicated on the drawings and as necessary for the proper and complete performance of work.

B. Panelboards shall be fully rated for available fault currents. Series ratings shall not be accepted.

C. Emergency (NFPA 70 Article 700), panelboards shall be equipped with devices such that selective coordination is maintained. The design intent in this specification and on the contract drawings has generally accounted for selective coordination. Illustrate the selectivity of proposed devices via the coordination study specified in Section 260573.

D. Section Includes:
1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 REFERENCES

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
1. National Electrical Code (NEC)
2. National Electrical Manufacturer's Association (NEMA).
   a. PB-1 Panelboard
   b. PB1.1General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
3. Underwriter's Laboratories (UL)
   a. UL 50 Enclosures for Electrical Equipment
   b. UL 67 Panelboards
   c. UL 508 Standard for Safety Industrial Control Equipment
4. American National Standard Institute (ANSI)

1.4 SUBMITTALS

A. Panelboards shall be submitted subsequent to the fault current and coordination studies required in 260573. Equipment submittals prior to the required study shall not be reviewed by the Design Engineer and will be returned "rejected."

B. Panelboards shall be submitted in a logical fashion and follow the order scheduled on the drawings. Disorganized submittals shall not be reviewed by the Design Engineer and will be returned "rejected."

C. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

D. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus material, configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices confirming fully rated equipment (series rating of circuit breakers is not acceptable).
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.

E. Qualification Data: For qualified testing agency.

F. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

H. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance Manuals.

B. Inspect and report concealed damage to carrier within their required time period.

C. Protect equipment throughout construction from damage, weather, excessive temperature, and construction operations.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other trades and construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to dedicated equipment space and workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Manufacturers

   1. The design is based on Square D to establish standards of quality for materials and performance. The naming of a specific manufacturer or catalog number does not waive any requirements or performance of individual components described in the specification. Provide Square D Series

NQOB and NF for 225A and below for receptacle and lighting panels and I-Line for distribution and panels above 225A.

2. Eaton Cutler-Hammer panelboards shall be Type PRL-1 for 225A and below for receptacle and lighting panels, Cutler-Hammer PRL-3 for distribution to 225A and Cutler-Hammer PRL-4 for distribution to 1200A.
3. GE panelboards shall be Series A for 225A and below for receptacle and lighting panels, GE Spectra Series for panelboards and distribution panels above 225A.
4. Siemens panelboards Type P1, P2 or P3 for 225A and below for receptacle and lighting panels, Type P4 and P5 for panelboards and distribution panels above 225A.

B. Enclosures: Flush- and surface-mounted cabinets as indicated in the contract documents.
1. Rated for environmental conditions at installed location.
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover (door in door type). Opening inner door shall expose circuit breaker operator handles and panelboard directory. Opening outer door shall expose terminals and circuit breakers in a single operation.
3. Where two section panels are required, bolt boxes together to form one unit. Trim shall be two-piece construction with doors of equal size over each section.
4. Power and lighting panels shall have heavy duty, continuous, section vertical-hinging to box section for access to wiring gutters in addition to trim door
5. All flush mounted panelboards mounted in common corridors shall have the same size enclosure regardless of pole space.
6. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
7. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Galvanized steel.
8. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover. Directories shall be typed showing use of each circuit and the panelboard designation.
9. Panelboard designations shall be labeled on the front of the panel with a screw-on nameplate.

C. Incoming Mains Location: Top or bottom.

D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PANELBOARDS

A. Panelboards shall meet or exceed requirements of NEMA Standard Publication PB-1 and UL-50 and 67. Provide cabinets with flush hinges and combination catch and lock. Provide wiring gutters to accommodate large multiplier feeder cables and lugs. Except as shown otherwise on drawings, wiring gutters shall be at least 4" for lighting and 208V panels and 6" for 480V panels.

B. Panelboards shall have short circuit current rating equal to or greater than circuit breaker AIC ratings schedule on drawings. Panelboards rated 240 volts shall have the following minimum ratings:
1. 10k AIC where shown fed via a 150 kVA transformer and less.
2. 22k AIC where shown fed via a 225 kVA and 300 kVA transformer.

C. Panelboards served from transformers shall have a main breaker, unless an enclosed circuit breaker or fused switch is shown.

D. Main bus bars shall be copper, sized as required by UL standards to limit temperature rise on current carrying parts to 50°C above ambient 40°C maximum. Main bus bars shall be sized at least to full rating of feeders overcurrent device that feeds the panelboard.

E. Provide molded case, bolt-on, thermal-magnetic trip, single, two or three pole branch circuit breakers as shown on drawings. Multiple pole breakers shall be single handle, common-trip. Circuit breakers shall be listed and labeled for 75°C conductor ampacities.

F. Provide bus connections for future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and voltage clearances, where required on drawings. Provide for ready insertion of future breaker.

G. Provide separate equipment ground bus for each panelboard.

H. Panelboards served from K-rated transformers shall have neutral bus sized for 200% rated neutral conductors. Neutral bus shall be isolated form panelboard enclosure.

I. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Main and Neutral Lugs: Compression type.
2. Ground Lugs and Bus-Configured Terminators: Compression type.
3. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

J. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

K. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.
   4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      d. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
      e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
      f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position. Utilized for multi-circuit feeds for system furniture and surface metal raceway.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards at delivery before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine the areas and conditions under which panelboards are to be installed and notify engineer in writing of conditions detrimental to the proper and timely completion of work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards where indicated, in accordance with manufacturer's written instructions, guidelines and the applicable requirements of the NEC, local codes, the National Electrical Contractors Association's "Standard of Installation" and in accordance with recognized industry practices to ensure that products serve the intended function.

B. Install all flush mounted panelboards with one spare 1½ -inch and two ¾" conduits from panel to above accessible ceiling.

C. Location:
   1. Maintain the minimum NEC clearances about the equipment.
   2. Locate top of enclosures approximately 6'-6" above floor, at a masonry joint if applicable. Panelboard shall never be mounted such that the handle of the highest circuit breaker exceeds 6'-6" AFF.
   3. Provide 1/2" spacers for panelboards mounted at exterior walls below grade to establish an air space behind panel.

D. Anchoring:
   1. Provide all necessary hardware to secure panelboard in place. Anchor enclosure firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

E. Branch circuit wiring shall be peeled out of the wiring gutters at 90 degrees to circuit breakers and terminal lugs for a neat installation.

F. Install overcurrent protective devices and controllers not already factory installed.

G. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 BALANCING LOADS

A. After Substantial Completion, but not more than two months after Final Acceptance, conduct load balancing measurements and circuit changes as follows:
   1. Perform measurements during period of normal working load as advised by the Owner.
   2. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with the owner to avoid disrupting critical 24-hour services such as laser printers, and on line data processing, computing, transmitting and receiving equipment.
   3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test record.
   4. Tolerance: Difference between phase loads exceeding 20 percent at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Directories:
   1. Fill out the enclosure circuit directory card upon completion of work and install in panelboard.
   2. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
   3. Incorporate Owner's final room designations. Obtain approval before installing.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

N:\N0912.00\DOC\SPEC\2012_03-16_BID\262416_PANELBOARDS.DOC

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Twist-locking receptacles.
   3. Weather-resistant receptacles.
   4. Snap switches and wall-box dimmers.
   5. Floor service outlets, and multioutlet assemblies.
   6. Poke-through assemblies.

B. Related Sections
   1. Division 27, "Telecommunications Cabling System" and telecommunications drawings for multi-media floor boxes, and faceplates.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 5351 (single), CR5362 (duplex).
      b. Hubbell; HBL5351 (single), HBL5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).
      d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 GFCI RECEPTACLES

A. General Description:
   1. Straight blade, feed-through type.
   2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
   3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; VGF20.
      b. Hubbell; GFR5352L.
      c. Pass & Seymour; 2095.

d. Leviton; 7590.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, Ratings as indicated on drawings: Comply with NEMA WD 1, NEMA WD 6 Configuration: As indicated on drawings.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; CWL.
b. Hubbell; HBL.
c. Leviton.
d. Pass & Seymour.

2.6 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; AH1221.
b. Hubbell; HBL1221.
c. Leviton; 1221-2.
d. Pass & Seymour; CSB20AC1.
e. Two Pole:
f. Cooper; AH1222.
g. Hubbell; HBL1222.
h. Leviton; 1222-2.
i. Pass & Seymour; CSB20AC2.
j. Cooper; AH1223.
k. Hubbell; HBL1223.
l. Leviton; 1223-2.
m. Pass & Seymour; CSB20AC3.

2.7 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimming ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming down to 5 percent.

2.8 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
3. Material for Unfinished Spaces: Galvanized steel.

4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable in-use cover.

2.9 FLOOR SERVICE FITTINGS

A. Type: Modular, dual-service units suitable for wiring method used. See telecommunication drawings for detail of types RFB4 and EFB8 series multi-media boxes.

B. Compartments: Barrier separates power from voice, data and audio-visual cabling.

C. Service Plate: Rectangular, surface style cover with solid lid. Color as selected by architect.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, white finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: As indicated on telecommunication details.

F. Fire rated type boxes required as indicated on drawings.

2.10 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wiremold/ Legrand or comparable product by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.

B. Description:
1. Two-piece surface aluminum raceway, with factory-wired duplex receptacles.
2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Aluminum.

D. Multioutlet Harness:
1. Receptacles: 20A, 125V pre-wired.
2. Receptacle Spacing: As indicated on drawings.
3. Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles, as indicated on drawings.

2.11 POKE-THROUGH ASSEMBLIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wiremold/Legrand or comparable product by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.

B. Description:
1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly. See drawings for power only and combination type.

2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks complying with requirements in Section 271500 "Communications Horizontal Cabling."
4. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

2.12 EMERGENCY POWER-OFF PUSH BUTTON

A. Provide push button station with lift-up type cover in laboratories as indicated on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Provide separate neutral for multi-circuit homeruns indicated on drawings.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
   1. Install dimmers within terms of their listing.
   2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

N:\N0912.00\DOC\SPEC\2012_03-16_BID\262726 FL - WIRING DEVICES.DOC

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600-V ac and less for use in enclosed switches.
   2. Spare fuse cabinet.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   3. Fuse sizes for elevator disconnect switches. Coordinate required fuse size with elevator shop drawings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   4. Coordination charts and tables and related data.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

B. Coordinate fuse ratings for elevator motors with elevator shop drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Motor Branch Circuits: Class RK1, time delay.
   2. Other Branch Circuits: Class RK1, time delay.
   3. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare fuse cabinet within main electric room.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

N:\N0912.00\DOC\SPEC\2012_03-16_BID\262813 FL - FUSES.DOC

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Fusible switches.
2. Nonfusible switches.
3. Shunt trip switches and push buttons.
4. Molded-case circuit breakers (MCCBs).
5. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

C. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240-V ac for 120/208V systems, 600-V ac for 277/480V systems, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240-V ac for 120/208V systems, 600-V ac for 277/480V systems, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES - ELEVATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
   3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses. Coordinate fuse rating with elevator shop drawings.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:
   1. Oiltight key switch for key-to-test function.
   2. Oiltight green ON pilot light.
   3. Isolated neutral lug; 100 percent rating.
   4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
   5. Form C alarm contacts that change state when switch is tripped.
   6. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
   7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

2.6 SHUNT TRIP PUSH BUTTONS

A. Red push button device. 24-volt low profile with normally open contact blocks mounted within protective lift-up cover.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 262816

N:\N0912.00\DOC\SPEC\2012_03-16_BID\262816_ENCLOSED SWITCHES.DOC

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:
   1. Full-voltage manual and magnetic

B. Related Section:

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
   1. Show tabulations of the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Nameplate legends.
      d. Short-circuit current rating of integrated unit.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for enclosed controllers and installed components.

2. Manufacturer's written instructions for setting field-adjustable overload relays.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions or clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle action; marked to show whether unit is off, on, or tripped.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Rockwell Automation, Inc.; Allen-Bradley brand.
      d. Siemens Energy & Automation, Inc.
      e. Square D; a brand of Schneider Electric.
   2. Configuration: Nonreversing.
   3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type; melting alloy type.
   4. Surface mounting.
   5. Red pilot light.

C. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      c. Rockwell Automation, Inc.; Allen-Bradley brand.
      d. Siemens Energy & Automation, Inc.
      e. Square D; a brand of Schneider Electric.
   2. MCP Disconnecting Means:
      a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
      b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
      d. N.C. alarm contact that operates only when MCP has tripped.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty type.
      a. Push Buttons: Shrouded.
      b. Pilot Lights: LED types; colors as indicated; push to test.
      c. Selector Switches: Rotary type.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

C. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote equipment as indicated. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages.
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust the trip settings of MCPs with adjustable instantaneous trip elements.

C. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

END OF SECTION 262913

N:\N0912.00\DOC\SPEC\2012_03-16_BID\262913_ENCLOSED CONTROLLERS.DOC

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Refer to Division 26 Section “Electrical System Commissioning” for scope of commissioning requirements.

1.2 SUMMARY

A. This Section includes packaged engine-generator set for emergency and optional-standby power supply with the following features:
   1. Diesel engine.
   2. Unit-mounted cooling system.
   3. Unit-mounted and Remote-mounting control and monitoring.
   4. Sound Attenuated Outdoor enclosure.

B. Related Sections include the following:
   1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
   2. Division 26 Section “Overcurrent Protective Device Coordination Study” for selective coordination study.
   3. Division 26 Section “Electrical System Commissioning” for scope of commissioning.

C. Requirements for affidavit
   1. Notify the Design Professional in writing that the life safety systems are complete at least five (5) working days prior to requesting final certification of completion ("affidavits") from the Architect/Engineer. The notification shall be in the form of a single formal document endorsed by an individual charged with management responsibility for all trades associated with the life safety systems.
   2. In order for an affidavit to be signed the generator and the emergency system shall be tested per NFPA 110
   3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified herein. The NFPA test generally consists of a cold start, a 2 hour load test, a 5 minute cool down, a 100% load test and then another 2 hour load test for a total test time of 4 hours and 5 minutes.
   4. All completed testing forms shall be submitted to the Design Professional a minimum of two (2) days prior to requiring affidavits.
   5. Secure Maryland of Environment (MDE) air quality permits- to-construct for all fuel burning equipment where required.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 SUBMITTALS

A. Product Data: For packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
   1. Thermal damage curve for generator.
   2. Time-current characteristic curves for generator protective devices.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
   2. Wiring Diagrams: Power, signal, and control wiring.
   3. Over-current protection, relays and control devices shall be identified and their ratings marked.
   4. Noise Emissions: Provide a submittal with suitably supported and documented noise emission calculations or measurement data to demonstrate compliance with noise levels outlined in the specification. The submittal shall ensure all aspects of noise emission from the unit have been included.
   5. Copy of blank NFPA 110 Acceptance Test form for review.

C. Qualification Data: For manufacturer and testing agency.

D. Source quality-control test reports.
   1. Certified summary of prototype-unit test report.
   2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   4. Report of sound generation.
   5. Report of exhaust emissions showing compliance with applicable regulations.
   6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

G. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator set and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

J. Comply with UL 2200.

K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
   1. EPA/Tier-3.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
   1. Ambient Temperature: 5 to 40 deg C.
   2. Relative Humidity: 0 to 95 percent.
   3. Altitude: Sea level to 1000 feet.

1.7 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators on grade. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generator and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 2 years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
   2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
   3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Caterpillar; Engine Div.
   2. Kohler Co.; Generator Division.
   3. MTU Onsite Energy Corporation - Detroit Diesel
   4. Onan/Cummins Power Generation; Industrial Business Group.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated on drawings.
   2. Output Connections: Three-phase, four wire.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:
   1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
   2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
   3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
   4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
   5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
   6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
   7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:
1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Mechanical.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
   a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
   b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24-V electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
   a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
   f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet, within enclosure.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
1. Tank level indicator.
2. Capacity: Fuel for eight hours' continuous operation at 100 percent rated power output.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.
5. Bas Interface: Provide hardware interface for connection to Division 23 Building Automation System.

C. Fuel Filling System: System shall be a simplex automatic fuelport, model AFP-3 by Simplex, Inc.

1. Provide for free standing installation at SA building existing utility yard. Simplex automatic fuelport grade level fill box with spill containment, overfill prevention and automatic fill shutoff in the filling of the generator base-mounted fuel oil tank.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator or circuit breakers, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:
   1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
   2. Switchboard Construction: Freestanding unit complying with Division 26 Section "Switchboards."
   3. Current and Potential Transformers: Instrument accuracy class.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level [**1**] [**2**] system, and the following:
   1. AC voltmeter.
   2. AC ammeter.
   3. AC frequency meter.
   4. DC voltmeter (alternator battery charging).
   5. Engine-coolant temperature gage.
   6. Engine lubricating-oil pressure gage.
   7. Running-time meter.
   8. Ammeter-voltmeter, phase-selector switch(es).
   9. Generator-voltage adjusting rheostat.
   10. Fuel tank derangement alarm.
   11. Fuel tank high-level shutdown of fuel supply alarm.

E. Indicating and Protective Devices and Controls:
   1. AC voltmeter.
   2. AC ammeter.
   3. AC frequency meter.
   4. DC voltmeter (alternator battery charging).
   5. Engine-coolant temperature gage.
   6. Engine lubricating-oil pressure gage.
   7. Running-time meter.
   8. Ammeter-voltmeter, phase-selector switch(es).

9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Generator overload.

F. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

G. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.

H. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Locate in building engineers office.
1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

I. Remote Emergency-Stop Switch: Surface mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation, and located within emergency electrical room.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Mounting: Adjacent to or integrated with control and monitoring panel.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, custom weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure. Enclosure to accommodate four (4) circuit breakers as indicated.

B. Sound Attenuation
   1. The enclosure shall be designed for a 25 dBA reduction at 1 meter from the enclosure.

C. Description: Custom enclosure with the following features:
   1. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
   2. Hinged Doors: With padlocking provisions.
   3. Muffler Location: Within enclosure.
   4. Barriers between circuit breakers per article 700 of the NEC.

D. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
   1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
   2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.9 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
   1. Material: Standard neoprene.
   2. Durometer Rating: 30.
   3. Number of Layers: Two.

2.10 FINISHES

A. Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 03 Concrete and Division 26 Section "Hangers and Support for Electrical Systems."

D. Contractor to provide assistance to Division 23. Contractor necessary for fully functioning remote monitoring of tank level indicator.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Division 23 Section "Facility Fuel-Oil Piping."

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. The system shall have two tests. The first test shall be a Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Generator Pre Testing
      a. Pre-testing is required to prepare for the Installation Acceptance Test. Prior to scheduling the Installation Acceptance Test, a Pre-Acceptance Test of the system is performed by the contractor to verify that the system is operating properly and is ready for the Installation Acceptance Test.
      b. Pre-Acceptance Test Procedure:
         1) The Pre-Acceptance Test is typically performed two weeks prior to scheduling the Installation Acceptance Test.
         2) Verify that the generator starts and runs when normal power is shut off.
         3) Operate the Generator long enough to assure it is operating properly, to verify it starts and transfers load to emergency loads in less than 10 seconds, and that all connected equipment is operating properly.
         4) Verify that dampers open and ancillaries operate properly.
         5) Verify that fuel delivery system is operational and functioning as designed.
         6) Check and adjust equipment.
         7) Set and verify time delays on transfer switches.
         8) Correct deficiencies and verify that the system is ready for the Installation Acceptance Test.
         9) The Owner’s representative should witness this test.
   3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
   4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
      b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
      c. Verify acceptance of charge for each element of the battery after discharge.
      d. Verify that measurements are within manufacturer's specifications.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Tank to be completely filled at conclusion of all testing.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 263213

Project Location:

Project Description: _____

Date of Test: _____ **Witnessed By:** _____

System Classification: Emergency Standby Optional Standby
(NEC) (NEC 700) (NEC 701) (NEC 702)

Level: Level 1 Level 2 Other
(2002 NFPA 110 Paragraph 4.4)(Emergency)(Typically Standby) (Optional Standby)

Classification: Class 2 Class 6 Class 48 Class X
(2002 NFPA 110 Table 4.1.a) (2 Hours) (6 Hours) (48 Hours) (Other Time, (Length of Time) in hours)

Type: Type 10 Type 60 Type 120 Type M
(2002 NFPA 110 Table 4.1.b) (10 seconds) (60 seconds) (120 seconds) (Non-automatic) (Lights off till Lights on)

Test Procedure: Follow the sequence below. The sequence follows the NFPA 110 Acceptance Testing procedure outlined in Paragraph 7.13, Installation Acceptance, in the 2002 Edition of NFPA 110. The **Operational Test** is conducted **prior** to the **Full Load Test** (Load Bank Test) in accordance with NFPA 110.

OPERATIONAL TEST: ***This phase of the test verifies operation of the generator start circuit, transfer switches, and verifies that all loads connected to the generator are energized. The load bank is not used for this part of the test.***

Cold Start Condition: The generator should not be run prior to the test on the day of the test.

Normal Building Loads On: Prior to starting the test, verify that normally operating building loads are connected and operating.

At Time t = 0, Open All Service Switches to the building.

Record the following:
TIME DELAY ON START: **Seconds**
(From time t = 0, measure the time till the generator starts to crank. NFPA 110 7.13.4.1.3)

CRANKING TIME FOR START/RUN: **Seconds**
(Time between engine starting to running per NFPA 110 7.13.4.1.4)

TIME TO REACH OPERATING SPEED: _____ Seconds
(From time t = 0, per NFPA 110 7.13.4.1.5)

VOLTAGE OVERSHOOT: **Volts**
(Per NFPA 110, 7.13.4.1.6)

FREQUENCY OVERSHOOT: _____ **HZ**
(Per NFPA 110, 7.13.4.1.6)

ATS TRANSFER TIMES
(From Time t = 0, record the time for each ATS to transfer load to the generator. In general, it's the time from lights off until lights on. NFPA 110 7.13.4.1.7)

ATS 1**:** **Seconds**

ATS 2**:** _____**Seconds**

ATS 3**:** **Seconds**

ATS 4: S**econds**

AT STEADY STATE
(Record per NFPA 110 7.13.4.1.8, 9)

Volts: _____VAB _____VBC _____VCA

_____VAN _____VBN _____VCN

Amperes: _____ Ø A _____Ø B _____ Ø C

Oil Pressure: **PSI**

Water Temperature: _____ ° F

The Test Continues for 2 Hours: During the two hours, the Owner's Representative will verify that all loads connected to the generator are energized. Exit lights and egress lighting will be checked for proper operation. The fire pump and elevators will be operated if connected to the generator. (NFPA 110 7.13.4.11)

Record Battery Charge Rate & Power Fluctuations as Follows:

Time minutes	Oil Pressure	Water Temp F	Battery Charge Rate	Kilowatts	Amperes			Volts Line - Line			HZ	Remarks (Load Changes Observed)
					Ø A	Ø B	Ø C	Vab	Vbc	Vca		
0												
5												
10												
15												
30												
45												
60												
75												
90												
105												
120												

Shaded areas are recorded if load changes are observed.

At Time t = 2 hours, **Restore Normal Power**

Record the following:
ATS TRANSFER TIMES
(From Time t = 2 hours, record the time for each ATS to transfer load back to the normal source. NFPA 110 7.13.4.1.12)

ATS 1**:** **seconds**

ATS 2**:** _____**seconds**

ATS 3**:** **seconds**

ATS 4: **seconds**

TIME DELAY FOR COOLDOWN: Minutes
(From time last transfer switch transfers back to normal power till generator shuts down. NFPA 110, 7.13.4.1(13). Delay should be 5 minutes minimum per NFPA 110 6.2.10 for units greater than or equal to 15KW.

Cool Generator for 5 Minutes
(NFPA 110 7.13.5)

FULL LOAD TEST (Load Bank Test): This phase of the test is an endurance test of the generator. Disconnect building load from generator and connect a load bank that is equal to 100% of the nameplate KW rating of the generator.

Connect Load Bank to the generator. Load Bank shall be equal to 100% of the generator rating (NFPA 110 7.13.6)

Initiate Full Load Test immediately after the 5 minute cool down that followed the Operational Test (NFPA 110 7.13.7). Apply 100% load as soon as the generator is running and stable.

Record the following:
(NFPA 7.13.8)

CRANKING TIME FOR START/RUN: **Seconds**
(Time between engine starting to running)

TIME TO REACH OPERATING SPEED: _____ Seconds

VOLTAGE OVERSHOOT: **Volts**

FREQUENCY OVERSHOOT: _____ **HZ**

Time minutes	Oil Pressure PSI	Water Temp ° F	Battery Charge Rate	Kilowatts	Amperes			Volts Line - Line			HZ
					Ø A	Ø B	Ø C	Vab	Vbc	Vca	
0											
15											
30											
45											
60											
75											
90											
105											
120											

Shutdown Generator. The test is complete.

END OF SECTION 263213

N:\N0912.00\DOC\SPEC\2012_03-16_BID\263213_ENGINE GENERATORS.DOC

SECTION 263300 – PHOTOVOLTAICS ARRAY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes solar energy systems. The design shall be a performance based system. The design includes proposed equipment layout and manufacturers data for planning purposes. The naming of a specific manufacturer or catalog number does not waive any requirements of performance of individual components described in the specification nor shall it limit the contractor in providing an alternate design.

B. These specifications cover the procurement of equipment, hardware, documentation, labor and supervision required for the installation of a maximum of 30 kW grid-connected PV systems. There will be no energy storage devices (e.g. batteries) used in these systems.

C. Bids must list all the equipment necessary to complete system installations. In addition, documentation on the design, configuration, installation, operation and maintenance of the complete system must be included.

D. Each PV system will be installed at site. The Contractor shall provide mounting (e.g. free standing, roof-mounting, etc.) the array in a manner that is acceptable with the Architect. The mounting specifics (e.g. have a 30-degree fixed tilt plane, be mounted parallel to roof, etc.) and oriented, either to the South or the West, shall be determined as local conditions dictate.

E. Each PV system will be connected to the PEPCO utility electric grid through a grid-interactive power conditioner (inverter). The design and specification of the PV modules, power conditioners, utility interconnections, PV system electrical design, and PV array mechanical design are described in the following sections.

F. The Contractor shall conduct a routine site visit every six (6) months during the standard warranty period to make sure the system is operating properly. During this visit, the Contractor shall conduct tests similar to those made during the original system acceptance test. This includes measurements of short-circuit current and open-circuit voltage. This also includes the instantaneous measurement of DC and AC current and voltage while the system is in operation. Irradiance and module temperature should be taken during all testing procedures. A report of the site visit shall be provided to the owner.

G. Extended Service Contract:
   1. The Contractor shall provide an option for an Extended Service Contract, thereby extending labor, technical assistance and routine maintenance. Routine maintenance is defined as the act of making sure the PV system operates properly. This includes changing blown fuses, diodes, or other minor equipment. This does not extend the warranties of factory-warrantied components such as the modules or inverters, but includes any labor required to change out these or other components that fail during the Extended Service Contract.

1.3 DEFINITIONS

A. Antireflection coating: A thin coating of material applied to a crystalline PV surface that reduces light reflection and thus increases solar radiation capture by the PV cell.

B. Balance of System (BOS): Non-PV components of a PV system typically include wiring, disconnects, diodes protecting modules from damage by reverse currents, mounting and attachment hardware, switches, and array power conditioning units, meters, and battery storage equipment.

C. Bypass diode: A diode connected across one or more solar cells in a PV module to protect these cells from thermal destruction in case of total or partial shading of individual cells while other cells are exposed to full light.

D. Conversion efficiency: Amount of electricity a PV device produces in relation to the amount of light shining on the device, expressed as a percentage. A PV cell's conversion efficiency varies with outside temperature and also slightly with age. Because of minor electrical losses, modules may be less efficient than modules per se, and losses in power conversion result in overall system efficiencies less than the conversion efficiency of the array.

E. Curtain wall: An exterior wall that provides no structural support.

F. Encapsulant: Plastic or other material around PV cells that protects them from environmental damage.

G. Grid-connected: Inter-tied with an electric power utility.

H. Inverter: Device that transforms direct currant (DC) electricity to alternating-current (AC) electricity.

I. Module: Commercial PV product containing interconnected solar cells; modules are offered in various standard sizes by high volume manufacturers; sizes and cell configurations for optical effect, etc. can be ordered from manufacturers at premium prices.

J. Net metering: In the United States, utilities are obligated, generally, to accept solar electricity production temporarily exceeding a building's consumption to the point that annual net purchases from the utility are zero as the utility company compensates the building owner for excess power returned to the grid.

K. PCS: Photovoltaic Control System

L. PV array: Group or string of connected PV modules operating as a single unit.

M. PV solar cell: Device made of semiconductor materials that convert direct or diffuse light into electricity; typical PV cells are made from wafers of crystalline silicone or thin films of silicon and other materials that form light sensitive semiconductor junctions.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Disconnect Switch
   2. Inverter
   3. Lightning arrestor
   4. Combiner Box
   5. Fuses
   6. Solar Panel

B. Overview of major system components and principles of operation.

C. Complete parts lists, including all electrical components, mechanical hardware and other equipment required for installing the systems (must include description and make for all the equipment provided, model/part number and source are also required for the PV modules and the inverter).

D. Diagram indicating proposed layout of entire system, including PV array, and location of BOS hardware and PCS with respect to the array.

E. Electrical schematics and diagrams showing all major components and devices, including conductor types and sizes, connections of individual modules and array source circuits, terminations at junction boxes, connection to surge suppression devices and the PCS, and the PCS interface with the utility grid.

F. Mechanical drawings showing details of module/array mechanical support.

G. All equipment manufacturer's specifications and operations manuals, including those for PV modules, PCS, overcurrent devices, disconnects and optional equipment.

H. Complete assembly and installation instructions for mounting array, junction boxes and enclosures, routing Conduit, wiring arrays, and terminating conductors at array, combiner boxes and PCS.

I. Procedure for commissioning, operating, disconnecting, servicing and maintaining complete system and individual components.

J. Local/Regional Materials:
   1. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
   2. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
   3. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
   4. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.

K. Renewable Energy:
   1. Submit manufacturer's product data for system.
   2. Submit Letter of Certification from system provider indicating that energy produced by the system represents minimum 30kW of power.

L. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

M. Source quality-control test reports.

N. Field quality-control test reports.

O. Operation and Maintenance Data: For central DC to AC inverter equipment to include in emergency, operation, and maintenance manuals.

P. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Solar Energy Systems:
   1. Photovoltaic Panels: Provide panels labeled with the PowerMark certification by PowerMark Corporation.
   2. Weathering:
      a. ASTM E1038-Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls
      b. ASTM E1171- Standard Test Method for Photovoltaic Modules in Cyclic Temperature and Humidity Environments
      c. ASTM E1596- Standard Test Methods for Solar Radiation Weathering of Photovoltaic Modules
      d. ASTM E1597- Standard Test Method for Saltwater Pressure Immersion and Temperature Testing of Photovoltaic Modules for Marine Environments
      e. ASTM E1802-Standard Test Methods for Wet Insulation Integrity Testing of Photovoltaic Modules
      f. ASTM E2047- Standard Test Method for Wet Insulation Integrity Testing of Photovoltaic Arrays
      g. ASTM E1830- Standard Test Methods for Determining Mechanical Integrity of Photovoltaic Modules
      h. ASTM E781- Standard Practice for Evaluating Absorptive Solar Receiver Materials When Exposed to Conditions Simulating Stagnation in Solar Collectors With Cover Plates
      i. ASTM E782- Standard Practice for Exposure of Cover Materials for Solar Collectors to Natural Weathering Under Conditions Simulating Operational Mode
      j. ASTM E823- Standard Practice for Nonoperational Exposure and Inspection of a Solar Collector
      k. ASTM E881- Standard Practice for Exposure of Solar Collector Cover Materials to Natural Weathering Under Conditions Simulating Stagnation Mode
   3. Calibration:
      a. ASTM E1039- Standard Test Method for Calibration of Silicon Non-Concentrator Photovoltaic Primary Reference Cells Under Global Irradiation
      b. ASTM E1362- Standard Test Method for Calibration of Non-Concentrator Photovoltaic Secondary Reference Cells
   4. Energy Performance:
      a. ASTM E948- Standard Test Method for Electrical Performance of Photovoltaic Cells Using Reference Cells Under Simulated Sunlight
      b. ASTM E1021- Standard Test Methods for Measuring Spectral Response of Photovoltaic Cells
      c. ASTM E903- Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
      d. ASTM E1040- Standard Specification for Physical Characteristics of Nonconcentrator Terrestrial Photovoltaic Reference Cells
      e. ASTM E1462- Standard Test Methods for Insulation Integrity and Ground Path Continuity of Photovoltaic Modules

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for a period of two (2) years.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
1. Fuses: One for every 10 of each type and rating, but no fewer than six (6) of each type.

1.9 INFORMATION PROVIDED BEFORE PROJECT COMPLETION

A. The Contractor is responsible for providing two complete copies of all installation, operations and maintenance manuals.

B. As-built diagrams indicating overall layout of entire system, including PV array, and location of BOS hardware and PCS with respect to the array.

C. A copy of the interconnection agreement between the owner and the utility must be provided.

D. The acceptance test outlined in Part 3 must be performed on the system.

E. A copy of the permit obtained from the appropriate legal authority for system installation.

F. A copy of the minimum two-year system warranty including parts and labor.

G. Array structural design information sealed by a professional engineer is required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Solar panel: BP Solar, USA

2.2 PV MODULE AND ARRAY SPECIFICATIONS

A. The PV modules should be framed flat-plate crystalline/amorphous silicon modules.

B. The PV array should be sized to achieve a nominal 30 kW DC STC output for the entire system under peak sun conditions (1000 W/m^2). In general, AC output should be around 70% of the DC kWp rating.

C. The PV modules shall meet or exceed the requirements of Underwriter Laboratories (UL) Standard 1703 Standard for Safety for Flat-Plate Photovoltaic Modules and either IEEE Standard 1262-1995 IEEE

Recommended Practice for Qualification of Photovoltaic (PV) Modules and Panels or IEC 1215 Crystalline Silicon Terrestrial Photovoltaic (PV) Modules- Design Qualification and Type Approval.

D. Each PV module shall include bypass diodes installed in the module junction box.

E. Each PV module shall be warrantied by the manufacturer for at least 90% of its rated power for 10 years and 80% of its rated power for 20 years from the date of system acceptance.

F. Modules shall be made in the U.S.A.

G. The PV modules electrical characteristics including current-voltage (I -V) curves and temperature coefficients of module power, voltage, and current shall be characterized by a research laboratory such as the Florida Solar Energy Center, the National Renewable Energy Laboratory, Sandia National Laboratories, or Arizona State University.

2.3 PHOTOVOLTAIC CONTROL SYSTEM

A. The PCS for each system must use a multiple inverter(s), designed specifically for utility grid interconnection of photovoltaic arrays and be capable of automatic, continuous, and stable operation over the range of voltages, currents, and power levels for the size and type of array used.

B. Each PCS shall be compliant with IEEE Std. 929-2000 (Recommended Practice for Utility Interface of Photovoltaic Systems) and have UL1741 (Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems). The PCS shall also comply with IEEE Std. 519 (Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems) and the latest applicable ANSI and FCC standards and addenda dated prior to the award of the purchase order for this procurement.

C. The PCS must have an automatic visual indicator showing whether the system is on-line or not.

D. The PCS must have at least a two-year repair or replacement warranty from the manufacturer covering parts and labor.

E. The PCS, AC and DC disconnects, and any other required electronics shall be installed near the array, where they may be exposed to weather and possible vandalism. The contractor will provide a suitable pad-mountable, lockable enclosure for housing these components. This enclosure shall provide any venting and weather sealing required by the electronics enclosed. All electrical enclosures shall be rated as NEMA 3R or better and have superior strength and corrosion resistance properties.

F. Loss of Line: The PCS shall not operate without the line voltage present. The PCS shall sense a "loss of line" (utility) condition and shall automatically disconnect from the line. In the event of multiple PCSs and/or balanced load on a common line, the PCS shall contain circuits (such as Sandia Voltage Shift and Sandia Frequency Shift) that will cause the PCS voltage or frequency to drift downwards under loss of line conditions and cause it to cease energizing the grid within two seconds after loss of line. The PCS restart shall occur automatically after restoration of line voltage and frequency for at least five minutes.

G. The PCS shall be capable of completely automatic operation, including "wake-up," "sleep" mode and shutdown after loss of utility power. In the automatic mode, the PCS shall monitor the available PV array power and voltage, and when a predetermined amount of power threshold of 200 watts maximum is available and the array voltage is within the normal starting voltage, the wake-up sequence shall be initiated. The PCS shall monitor the AC line voltage and frequency and, when the AC voltage is within the normal operating range (450 to 490 V for nominal 480 V) and the frequency is between 59.5 and 60.5 Hz, the synchronization process shall be initiated prior to establishing line-tie. The shutdown sequence to place the PCS in "sleep" mode shall not be initiated above 200 watts of array power. The DC power

source and/or the AC circuit may remain connected in the "sleep" mode to provide monitoring and instrumentation power during nighttime operation.

H. The PCC shall be provided with a web interfaced monitoring system for the PV system to include displays of real time system performance.

2.4 PV SYSTEM ELECTRICAL DESIGN

A. The electrical design and installation instructions for the PV systems shall conform to the 2008 National Electric Code (NFP A 70). Article 690 of the NEC applies specifically to photovoltaic system safety, protection, control and interface with other sources. Other articles of the NEC also apply. The PV system electrical design shall also comply with the IEEE Std. 1374-1998 (Guide for Terrestrial Photovoltaic Power System Safety).

B. All electrical components, including overcurrent protection, disconnect, surge suppression devices, conduit, wiring and terminals must have UL or equivalent listing and have appropriate voltage, current and temperature ratings for the application. Special attention should be given to appropriate ratings for components used in DC circuits.

C. All wiring shall be listed for a minimum operation of 600 volts and temperature rating of 90° C in wet locations. All current carrying conductors shall be enclosed in conduit, including module interconnections.

D. Ampacity calculations must take into account appropriate de-ratings as required. All conductors in the system are subject to a 125% NEC de-rate, and all DC source circuit conductors and overcurrent devices must include an additional 125% de-rate for solar radiation enhancement. Appropriate temperature de-ratings for conductors used in module junction boxes must be considered for peak module operating temperatures, as well as de-ratings for instances where more than three current-carrying conductors are enclosed in a conduit.

E. Voltage drop in array DC source circuits should be limited to no more than five percent (5%), including losses in conductors and through all fuses blocking diodes and termination points.

F. All overcurrent devices shall have trip ratings no greater than the de-rated ampacity of the conductors that it protects.

G. All series connected strings of modules (also known as panels, or source circuits) must include a series fuse as required by UL and NEC to prevent to wiring or other system components. Parallel connections of modules in individual source circuits are not permitted. Parallel-connected cells within individual modules are allowable as long as the module listing allows for the series fuse required for this configuration.

H. All series connected strings of modules (source circuits) must also include a blocking diode to prevent reverse currents. These diodes should have low voltage drop to meet the requirements above, and have a voltage and current ratings (at temperature) at least twice the open-circuit voltage and short-circuit ratings of the source circuits.

I. Ground-fault protection devices shall be included as part of the PCS packages as required by the NEC. These devices must be capable of detecting array ground faults, shunting the fault current to ground, and disabling the array until the fault has been cleared.

J. All terminations must use listed box terminal or compression type connections. Twist on wire splices, crimped, soldered or taped connections are not permitted for the required field installed wiring. Proper torque specifications should be provided for all of the required field connections.

K. All module frames, panel/array support structures, metal enclosures, panel boards and the PCS cabinet should be provided with connections for bonding to a common grounding conductor and terminating at the ground rod at the utility service entrance point. In addition, provisions for grounding the neutral of the PCS output shall be provided. The DC negative circuit may be common to the AC neutral in the PCS design and under no circumstances should multiple connections to ground be specified for current carrying conductors in the system.

2.5 PV ARRAY MECHANICAL DESIGN

A. The Contractor shall provide the mechanical hardware for mounting the photovoltaic arrays. The Contractor shall provide all other hardware required for assembling the photovoltaic modules and panels and structurally attaching them to the structural steel tube.

B. The PV array, including modules, hardware and attachments shall be designed to withstand wind loads of 120 mph or more and comply with all existing local and national codes.

C. Array mounting hardware supplied by the bidder should be compatible with the site considerations and environment. Special attention should be paid to minimizing the risk from exposed fasteners, sharp edges, and potential damage to the modules or support structure. Corrosion resistance and durability of the mechanical hardware should be emphasized – the use of stainless steel fasteners and an aluminum support structure is preferred. The use of ferrous metals, wood or plastic components are strongly discouraged. Galvanic corrosion should be avoided.

D. As these are high profile, publicly visible installations, the aesthetics of the overall installation is extremely important. To create a uniform appearance of the array, spacing between individual modules and panels should be kept to a minimum. As much as possible, all mechanical hardware, conduit, junction boxes and other equipment should be concealed beneath and/or behind the array.

E. The array layout should be consistent with the ordering (and labeling) of source circuits in the array combiner boxes. Ease of access for array troubleshooting and maintenance is desired by allowing access to the back of the array for module junction box servicing, and removal/replacement of individual source circuits (panels) and modules if necessary.

F. All roof penetrations and installations on the building penthouse roof shall be approved by the certified roof manufacturer. The installation of the PV system shall be done in a manner which does not violate the roof warranty.

G. The Contractor shall provide an additional freestanding base structure for other locations equipped with a rigid frame, capable of receiving this same hardware.

2.6 SAFETY DISCONNECT SWITCHES

A. Provide disconnect switches as specified in Section 262816.

B. Disconnects located outside shall be NEMA 4X rated.

C. Disconnect at inverter shall be service entrance labeled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RESOURCE MANAGMENT

A. Energy Efficiency: Verify equipment is properly installed, connected, and adjusted. Verify that equipment is operating as specified.

B. Renewable Energy: Verify proper operation in all modes of system operation by testing. Verify proper operation under a wide range of conditions to verify energy delivery as calculated for those conditions.

C. Solar Energy Systems: Comply with ASTM E1799- Standard Practice for Visual Inspections of Photovoltaic Modules

3.3 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

C. Interface output from PV system inverter and provide real time energy performance parameters on the division 23 BAS System and building network.

3.4 IDENTIFICATION

A. Identify equipment and components according to NEC requirements.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
2. An acceptance test shall be performed on the system once the installation is complete. This includes measuring the short circuit currents and open-circuit voltages on all source circuits while measuring irradiance and module temperature. This also includes measuring the instantaneous DC input and AC output of the system to determine its efficiency.
3. Test manual and automatic operational features and system protective and alarm functions.
4. Test communication of status and alarms to remote monitoring equipment.

E. Remove and replace malfunctioning units and retest as specified above.

3.6 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that inverter is installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain photovoltaic system. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

N:\N0912.00\DOC\SPEC\2012_03-16_BID\263300 FL - PHOTOVOLTAICS ARRAY.DOC

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.

B. Related Sections include the following:
   1. Division 26 Section "Engine Generators" for control and monitoring of diesel generator.
   2. Division 26 Section "Electrical Systems Commissioning".

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
   1. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Features and operating sequences.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: Testing agency shall have the experience and capability to conduct the testing indicated, shall be a member company of the InterNational Electrical Testing Association or shall be a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

C. Source Limitations: Obtain isolation automatic transfer switches through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110.

I. Comply with UL 1008 unless requirements of these Specifications most restrictive.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Emerson; ASCO Power Technologies, LP.
2. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Provide 18,000 cycle transfer switch for life safety ATS.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching.

G. Neutral Switching. Provide overlapping neutral contacts. Simultaneous switching of phase and neutral conductors.

H. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

G. Automatic Transfer-Switch Features:
   1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
   b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identify components according to Division 26 Section "Identification for Electrical Systems."

B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:
   1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
      a. Check for electrical continuity of circuits and for short circuits.
      b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
      c. Verify that manual transfer warnings are properly placed.
      d. Perform manual transfer operation.
   4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
      a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
      b. Simulate loss of phase-to-ground voltage for each phase of normal source.
      c. Verify time-delay settings.
      d. Verify pickup and dropout voltages by data readout or inspection of control settings.
      e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

N:\N0912.00\DOC\SPEC\2012_03-16_BID\263600_TRANSFER SWITCHES.DOC

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Section.
1. Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding materials and sizes.

1.2 SUMMARY

A. Section includes lightning protection for structures and structure elements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air terminals and mounting accessories.
1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding and grounding and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

C. Field quality-control reports.

D. Roof and site plans showing dimensioned as-built locations of grounding features, including the following:
1. Ground rods.
2. Ground loop conductors.
3. Down leads.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.

B. System Certificate:
   1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dillon Lightning Protection Systems, Inc.
      b. ERICO International Corporation.
      c. Harger.
      d. Heary Bros. Lightning Protection Co. Inc.
      e. A-C Lightning Security, Inc.
      f. Preferred Lightning Protection.
      g. Thompson Lightning Protection, Inc.

C. Main and Bonding Conductors: Copper.

D. Ground Ring Conductor: As indicated on drawings.

E. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. Down conductors.
2. Interior conductors.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

G. Ground Ring: Install ground-level, potential equalization conductor and extend around the perimeter of building as indicated on electrical site plan and detail sheet.
1. Bury ground ring not less than 24 inches from building foundation.
2. Bond ground terminals to the ground ring.
3. Bond grounded building systems to the ground ring conductor within 12 feet of grade level.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION 264113

N:\N0912.00\DOC\SPEC\2012_03-16_BID\264113 FL - LIGHTNING PROTECTION FOR STRUCTURES.DOC

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Exit signs.
   3. Lighting fixture supports.

B. Related Sections:
   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including photoelectric relays, occupancy sensors, and contactors.
   2. Section 262726 "Wiring Devices" for manual wall-box dimmers for fluorescent lamps.
   3. Section 260933 "Central Dimming Controls" for dimming and switching cabinets.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Ballast, including BF.
   3. Energy-efficiency data.
   4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
    b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
    1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    2. Wiring Diagrams: For power, signal, and control wiring.

C. Installation instructions.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
    1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
    2. Furnish extra burned-in, "seasoned," fluorescent lamps, one for one, used for dimming that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated per lighting fixture schedule on drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Diffusers and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
2. Glass: Annealed crystal glass unless otherwise indicated.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter code (T-4, T-5, T-8, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
      c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
      d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
      e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
      f. CCT and CRI for all luminaires.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:
   1. Comply with UL 935 and with ANSI C82.11.
   2. Designed for type and quantity of lamps served.
   3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
   4. Sound Rating: Class A.
   5. Total Harmonic Distortion Rating: Less than 10 percent.
   6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   7. Operating Frequency: 42 kHz or higher.
   8. Lamp Current Crest Factor: 1.7 or less.
   9. BF: 0.88 or higher.
   10. Power Factor: 0.95 or higher.
   11. Manufacturer: Advance Transformer Company.

B. Luminaires controlled by occupancy sensors shall have electronic programmed-start ballasts.

C. Electronic Programmed-Start Ballasts for T8, T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
   1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
   2. Automatic lamp starting after lamp replacement.

D. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

E. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Deg F and Higher: Electronic type rated for 0 deg F starting and operating temperature with indicated lamp types.

F. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
   4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
   5. Manufacturer: Lutron HiLume Ecosystem

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: Class A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher unless otherwise indicated.
   9. Power Factor: 0.95 or higher.
   10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
   11. Manufacturer: Advance Transformer Company.

2.5 BALLASTS FOR HID LAMPS

A. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
   1. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
   2. Rated Ambient Operating Temperature: 130 deg F.
   3. Lamp end-of-life detection and shutdown circuit.
   4. Sound Rating: Class A.
   5. Total Harmonic Distortion Rating: Less than 20 percent.
   6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   7. Lamp Current Crest Factor: 1.5 or less.
   8. Power Factor: 0.90 or higher.
   9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
   10. Protection: Class P thermal cutout.
   11. Manufacturer: Advance Transformer Company.

2.6 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.7 FLUORESCENT LAMPS

A. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches, 2900 initial lumens (minimum), CRI 86 (minimum), color temperature 3500 K, and average rated life of 25,000 hours. Phillips: T5-Silhouette, F28T5/835.

B. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 86 (minimum), color temperature 3500 K, and average rated life of 25,000 hours. Phillips: T5HO, F54T5/835/HO

C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 16,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.
   1. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
   2. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
   3. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

2.8 HID LAMPS

A. Ceramic, Metal-Halide Lamps: Minimum CRI 80, and color temperature 3500 K.

2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
   1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.

2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

D. Suspended Lighting Fixture Support:
1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions.
1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Exterior luminaires with lamps and ballasts.
   2. Poles and accessories.

B. Related Sections:
   1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure, including tower used for large area illumination.

G. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
   1. Basic wind speed for calculating wind load for poles exceeding 49.2 feet in height is 100 mph .

1.5 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaires and accessories.
   3. Details of installation and construction.
   4. Luminaire materials.
   5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

1.6 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
   1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
   2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
   3. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in

operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.

J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

K. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

L. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As selected from manufacturer's standard catalog of colors.

M. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USES ONLY" and include specific lamp type.
      b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
      c. ANSI ballast type (M98, M57, etc.) for HID luminaires.

2.3 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:
   1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   2. Minimum Starting Temperature: Minus 22 deg F.
   3. Normal Ambient Operating Temperature: 104 deg F.
   4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
   5. Manufacturer: Advance Transformer Company.

2.4 HID LAMPS

A. Ceramic, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.

B. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65 and CCT color temperature of 4000 K.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Rectangular-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.6 ALUMINUM POLES

A. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

B. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole.

C. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches.
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
   3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

END OF SECTION 265600

N:\N0912.00\DOC\SPEC\2012_03-16_BID\265600 FL - EXTERIOR LIGHTING.DOC

SECTION 270000

TELECOMMUNICATIONS CABLING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Montgomery College Cabling Standards will serve as a design guide for this project.

1.2 SUMMARY

A. Section Includes:
1. UTP cabling.
2. Single mode-micrometer optical fiber cabling.
3. 50/125-micrometer optical fiber cabling.
4. 62.5/125-micrometer optical fiber cabling.
5. Multi-pair copper cable
6. Coaxial cable (radio frequency video).
7. Triax cable
8. Cable connecting hardware, patch panels, and cross-connects.
9. Telecommunications outlet/connectors.
10. Cable management system.
11. Pathways.
12. Cabling identification products.
13. Backboards.
14. Telecommunications equipment racks and cabinets.
15. Telecommunications service entrance pathways.
16. Grounding.
17. Pathways.
18. Telecommunications mounting elements.
19. Multiuser telecommunications outlet assemblies.

B. Related Sections:
1. Division 27 05 26 “Grounding and Bonding for Communications Systems “for voice and data cabling associated with system panels and devices.
2. Division 27 05 28.36 “Cable Trays for Communications Systems" for voice and data cabling associated with system panels and devices.

C. Bidding Requirements:
1. Bidder shall submit complete detailed proposals with line item cost representation for components and associated installation labor. Lump sum bids will not be accepted.
2. Bidders shall include as part of the bid response the following items:
   a. Installation schedule with proposed manpower assignments.
   b. Resumes for project manager and lead technician for this project.
3. Bidders shall review associated electrical, telecommunications infrastructure drawings to verify that necessary conduit and floor boxes will be provided by others. Bidders shall understand and coordinate shared infrastructure locations for telecommunications outlets. The Owner will provide no additional infrastructure to support the telecommunications

cabling systems Inside Plant (ISP) and Outside Plant (OSP). Any discrepancies with the identified infrastructure to support these systems should be questioned in the form of a request for information (RFI) during the bidding process. Be responsible for any additional infrastructure requirements after receipt of contract for this project. No wiremold or surface mounted raceways shall be approved on this project except where specified.

4. Unspecified Equipment and Material: Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide complete and functional Structured Cabling System shall be provided in a level of quality consistent with other specified items.
5. Bidders shall submit a "Telecommunications Trade Contractor Qualification Statement" as outlined in Appendix A of the Montgomery College Office of Information Technology Voice/Data/Video Cabling MDF/IDF Communications Room Standard Version 4.00 dated 5/5/2011.

1.3 DEFINITIONS

A. AFC: Above Finished Ceiling Riser

B. BICSI: Building Industry Consulting Service International

C. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways

D. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection

E. EF: Entrance Facility

F. EMI: Electromagnetic interference.

G. HC: Horizontal Cross Connect

H. IDC: Insulation displacement connector

I. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs)

J. LAN: Local Area Network

K. MC: Main Cross-connect

L. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors

M. NRTL: Nationally Recognized Testing Laboratory

N. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates

O. RCDD: Registered Communications Distribution Designer.

P. TR: Telecommunications Room

1.4 SYSTEM DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
   1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
   2. Horizontal cabling shall contain no more that one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.
   4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

D. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

E. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

F. Communications equipment room shall provide the space to house the equipment for the backbone and horizontal cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: The cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Comply with requirements of Section 01 33 00 - Submittal Procedures.

B. Submittal data is to be submitted in a three ring binder, a continuous spiral binder, or plastic binding that allows the booklet to lie flat while open. Each booklet shall contain the below in the following order:
   1. Cover Sheet.

a. Include name of supplying contractor and project name.

2. Detailed Bill of Materials.
   a. Include a listing of: component quantities, equipment manufacturer, model number, and description of each component being supplied, and the specification paragraph or drawing sheet that corresponds to the product. Failure to provide this information will result in the rejection of submittals.
3. Product Data.
   a. Include a catalog sheet per product of equipment listed in the Detailed Bill of Materials, in the exact order as the Detailed Bill of Materials. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include a image of the product. Photocopy duplications of the manufacturer's original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures. If more than one product is shown on the catalog sheet the intended product must be denoted by either an arrow or highlight.
4. Authorized Distributor Certificate.
   a. Recently dated (within one year from submittal date) support letter from manufacturer stating that the supplying contractor is an Authorized Distributor of the product being supplied.
5. Prequalification Warrantee.
   a. Recently dated (within one year from submittal date) support letter from manufacturer stating that the supplying contractor is Authorized to obtain for the owner the Special Warranty for Cabling System and the Special Warranty for System Assurance.
6. Prequalification Certificate.
   a. Copy of the installing technician(s) certificate of completion from the manufacturer's training school for the equipment being provided.

C. Shop Drawings are to be submitted on project standard full size and bound. Each shop drawing set is to include the below in the following order:
   1. Title Sheet.
      a. Containing, at a minimum, a list of all drawings in the set and a symbols legend defining each symbol used in the package.
   2. Riser Diagram.
      a. Show the relationship of TR's, the pathway between them, and cable connectivity to be installed.
   3. Video/CATV System Engineering.
      a. Depict device location by room number and device type. Delineate cable types and cable pathway for both riser and horizontal distribution. Calculate db loss and outline levels for each splitter, tap, amplifier, and outlet.
   4. Telecommunications Room Details.
      a. Plan Details of infrastructure and room fittings with clearances, Elevation Details of wall fields and rack details showing the relationship of rack mounted elements inclusive of Owner provided equipment (labeled as such).
   5. Typical Outlet Details.
      a. Detail each typical outlet type to be installed. Include manufacturer specific plates, jacks, and an example of labeling. Note on the drawing the typical application of each outlet type, for example; standard office, computer lab, ceiling mounted wireless access location, etc.
   6. Floor Plans.
      a. Show planned location for all elements and cable routing. Drawings should be at project standard scale clearly legible. Include outlet port numbers for each outlet.

D. Samples to be submitted for each typical outlet type to be installed complete with colored jack, finished faceplate, and sample labeling

E. Field quality-control reports. Submit copy of project status reporting form.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer and manufactures certified installer, who shall be present at all times when Work of this Section is performed at Project site. One half of remainder of the crew shall be at a minimum Registered Technicians by manufacture as part of their Certified Installer Program.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Installing company shall be certified by manufactures in aspects of design, installation and testing of optical and Category 6 metallic premise distribution systems, be a manufactures Value Added Reseller (VAR) in good standing and have a minimum of five (5) years experience on similar Structured Cabling Systems (SCS). Have a Registered Communications Distribution Designer (RCDD) on staff. Submit RCDD certificate and registration number with bid.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

F. Grounding: Comply with ANSI-J-STD-607-A.

G. NFPA 70 – National Electric Code, 2005

H. BICSI – Telecommunications Distribution Methods Manual, 11th Edition, 2006

I. NEMA – VE-1 – Metal Cable Tray Systems, 2002

J. NEMA – VE-2 – Metal Cable Tray Installation Guidelines, 2001

1.8 PRE-CONSTRUCTION CONFERENCE

A. The successful contractor shall schedule a pre-construction meeting with the College's IT Manager prior to any work commencing. This conference will review the scope of work, milestones, timelines, and other items as appropriate.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cable for open and short circuits.

B. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install equipment frames and ladder racking until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.11 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
   1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
   4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

C. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.12 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Patch-Panel Units: The greater of one (1) or 10% of total quantity of each type.
   2. Connecting Blocks: The greater of one (1) or 10% of total quantity of each type.
   3. Device Plates: The greater of ten (10) or 2% of total quantity of each type.

1.13 WARRANTY

A. Special Warranty for Cabling System: Manufactures warranty shall ensure against product defects; that approved cabling components exceed the specifications of TIA/EIA 568B, TIA/EIA 568B-5 and ISO/IEC IS 11801; exceed the attenuation and NEXT requirements of TIA/EIA-TSB-67 and ISO/IEC IS 11801 for cabling links/channels; and that the installation will exceed the loss and bandwidth requirements of TIA/EIA-TSB-67 and ISO/IEC IS 11801 for fiber links/channels. The warranty shall apply to passive SCS components.
   1. Warranty Period: 25 Year Performance Warranty from date of Substantial Completion.

B. Special Warranty for System Assurance: Manufactures warranty shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that recognize TIA/EIA 568B, TIA/EIA 568B-5 or ISO/IEC IS 11801 component and link/channel specifications for cabling.
   1. Warranty Period: 25 Year Applications Assurance from date of Substantial Completion.

C. Special Warranty for Tube Cabling System: Manufactures warranty shall ensure against product defects.
   1. Warranty Period: 25 year Performance Warranty from date of Substantial Completion.

D. Manufacturer's requirements, inspection, acceptance and issuance of Certificate of Warranty are the responsibility of the bidder. Certificate of Warranty in the College's name, is due within thirty (30) days of building Occupancy and Use Certificate (OUC) in the College Office of Central Facilities.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets in Telecommunications Rooms shall be designed to prevent degradation of cable performance and pinch points that could damage cable.

C. Non-continuous cable supports shall be used in any area above the finished ceiling where cable tray is not available.

D. Non-continuous cable supports
   1. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

2. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
3. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
4. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
5. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
6. Non-continuous cable supports shall be ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J-Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT-CMTM retainer CATRT200CM, CATRT300CM or approved equal.

E. Non-continuous cable support assemblies from drop wire/ceiling
1. Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
2. Acceptable products: ERICO CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.

F. Non-continuous cable support assemblies from beam, flange
1. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
2. Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.

G. Non-continuous cable support assemblies from C & Z Purlin
1. Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus listed.
2. Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY Purlin hangers; or approved equal.

H. Non-continuous cable support assemblies from wall, concrete, or joist
1. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus listed.
2. Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64, with CADDY angle bracket; or approved equal.

I. Non-continuous cable support assemblies from threaded rod
1. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
2. The multi-tiered support bracket shall have a static load limit of 300 lbs.
3. U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts.
4. Acceptable products: ERICO CableCatTM J-hook, CAT12, CAT21, CAT32, CAT64 with CADDY CATHBA series; CAT-CMTM Double J-hook CAT100CM, CAT-CMTM Direct mount U-hook CAT200CMLN, CAT300CMLN; or AFAB series; or approved equal.

2.2 CONDUIT AND BOXES

A. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceways and Boxes." Flexible metal conduit shall not be used.
1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.3 UTP CABLE

A. Manufacturer: Subject to compliance with requirements, provide products by Molex Premise

B. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   3. Comply with TIA/EIA-568-B.2, Category 6.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

C. UTP Cable to be Molex:
   1. CAA-0181P-BL (Blue) for Data drops
   2. CAA-0181P-02 (White) for Voice drops
   3. CAA -0181P-0x (Pink) for Emergency Notification System drops (MCFNET).

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by Molex Premise.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Voice Connecting Blocks: 110-style IDC Rack mounted with wire management. Integral with connector bodies, including plugs and jacks where indicated.
   1. Provide blocks for the number of cables terminated on the block, plus 25 percent spare.
   2. Category 6 Station Voice: Molex KPD-00080.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

E. Data Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables. All patch panels shall be 48 port.
   1. Number of Jacks per Field: One for each four-pair UTP cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.
   2. Patch panel to be Molex PID-020001G.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position eight conductor modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables; terminated with eight-position modular plug at each end. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure specified category performance. Patch cords shall have latch guards to protect against snagging.
   1. TR location: Provide one (1) patch cord to match cable and Jack Assembly category rating per port on the patch panel. Provide 50% 5’ in length and 50% 10’ in length.

2. Floor outlet locations: Provide one (1) patch cord to match cable and Jack Assembly category rating per eight-position eight conductor modular receptacle. Provide 25% 10' in length, 50% 15' in length and 25% 25' in length.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
   1. Data: KSJ-00018-BL (Blue)
   2. Voice: KSJ-00018-02 (White)
   3. Emergency Notification System Outlets (MCFNET): KSJ-00018-08 (Grey)
   4. Provide blanks for each unused port. Model KSJ-00005-02.

B. Workstation Outlets: Provide connector assemblies mounted in single or multigang faceplates as shown on contract drawings.
   1. Plastic Faceplate: High-impact plastic.
   2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
   3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

C. Faceplates to be Molex:
   1. 2-port; WSY-00018-02
   2. 4-port; WSY-00002-02
   3. 6-port; WSY-00001-02
   4. Biscuit; SSY-00002-02

2.6 RISER COPPER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by Superior Essex Inc.

B. Description: 100-ohm, 25-pair UTP, covered with a thermoplastic jacket .
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   3. Comply with TIA/EIA-568-B.2, Category 5e.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

C. Riser Copper Cable to be Superior Essex 51-478-48

2.7 RISER UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by Molex Premise.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Voice Connecting Blocks: 110-style IDC Rack mounted with wire management. Integral with connector bodies, including plugs and jacks where indicated.
   1. Provide blocks for the number of cables terminated on the block, plus 25 percent spare.
   2. Category 5e Tie Cable: Molex KPD-00061

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

2.8 OUTSIDE SERVICE PLANT COPPER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by Superior Essex Inc. (trunk) and Mohawk (station).

B. Trunk Cable Description: 100-ohm, 100-pair 24 AWG, covered with a Black polyethylene jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   3. Category 5.

C. OSP Trunk Copper Cable to be Superior Essex 04-104-31.

D. Station Cable Description: 100-ohm, Shielded, 4-pair 24 AWG, covered with a Black polyethylene jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   3. Category 5e.

E. OSP Station Copper Cable to be Mohawk M57562.

2.9 OUTSIDE PLANT CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the specified structured cabling solution manufacturer.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Voice Connecting Blocks: 110-style IDC Rack mounted with wire management. Integral with connector bodies, including plugs and jacks where indicated.
   1. Category 5e Tie Cable: Molex KPD-00061

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

2.10 COPPER CABLE PROTECTION UNITS

A. All copper circuits shall be provided with protection between each building with an entrance cable protector panel. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding

conductor between the protector ground lug and the EF ground point. The installation shall employ three-element solid state protector modules in building.

B. Lightning protection system and grounding must be provided for 230 volt analog voice applications. Confirm with Owner prior to ordering.

C. Lightning protection system to be:
   1. Tii Porta Systems; 25100-110-M110PC
   2. Tii Porta Systems; 25025-110-M110PC
   3. Circa; 1880ENA1/NSC-50

2.11 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Belden

B. Horizontal Coaxial Cable: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
   1. RG-6/ U.
      a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
      b. 18 AWG solid .040" bare copper conductor; gas-injected, gas-injected foam HDPE insulation.
      a. Duofoil and tinned copper braid shield (95%coverage)
      b. Suitable for indoor installations.
   2. Horizontal Coaxial Cable to be Belden 1695A

C. Riser/Backbone Coaxial Cable: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
   1. RG-11/ U.
      a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
      b. No. 14 AWG, .064" bare copper conductor; gas-injected, foam HDPE insulation.
      c. Duofoil and tinned copper braid shield (95%coverage).
      d. Suitable for indoor installations.
   2. Riser/Backbone Coaxial Cable to be Belden 7731A

2.12 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. F style Connectors to match cable type.
   2. F-type terminators: Blonder Tongue or Scientific Atlanta BTF-TP.

2.13 VIDEO SYSTEMS PARTS AND ACCESSORIES

A. Install a completely functional, bi-directional RF Broadband video systems with self-terminating video outlets a built-in 75-Ohm resistor and a connector-actuated switch that automatically terminates the line when a cable connector is removed. Install the station cable in a home run topology, with passive tap and split devices located in the TR's. A +3/ +6 db output range at identified RF video station outlet location is required.

B. Measure, confirm, adjust and test the available signal strength to +20 (in db value) in the main RF distribution amplifier or splitter output port located in the new BDF Room. Submit for approval a build quality riser drawing illustrating outlet locations with db loss calculated for each outlet prior to installation of any coaxial cabling.

C. Coaxial cable equipment: Provide The following equipment or Owner approved equivalent shall be used:
   1. Bi-directional Amplifier – Blonder Tongue BIDA 5400 series. Placed in the TR/MC and each TR/HC as needed to complete video system adjusting.
   2. Splitters and Directional Couplers – As needed to complete fully functional CATV distribution system as specified. Blonder Tongue LPD-8p

D. Provide the following optical fiber to RF video transcoding electronics or Owner approved equivalent shall be used::
   1. Multichannel RF Fiber Optic AM Transmitter BNI Solutions TR2100-7705-860-R17 in location to be furnished by owner.
   2. Multichannel RF Fiber Optic AM Receiver BNI Solutions TR2200-750(38)-R17 in the MDF of the project Building.

E. Splitters and Directional Couplers – As needed to complete fully functional CATV distribution system as specified.
   1. Insertion Loss:
   2.

Part #	Tap Value	@500 MHz
4062-4	3.5	N/A
4062-8	7.7	4.9
4062-11	11.0	2.8
4062-14	14.0	1.8
4062-17	17.0	1.5
4062-20	20.0	1.1
4062-23	23.0	1.0
4062-26	26.0	1.0

F. Full Feature Taps (FFT):
   1. Insertion Loss

Type	Tap Value	@500 MHz
4064-8	8.0	N/A
4064-11	11.0	4.5
4064-14	14.0	2.3
4064-17	17.0	1.8
4064-20	20.0	1.3
4064-23	23.0	1.2
4064-26	26.0	1.0

2.14 ITV AV WALLBOX, CABLE AND CONNECTORS.

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Kings
   2. Amphenol Conex
   3. Neutrik
   4. Belden Inc.

B. Indoor ITV AV wallbox
   1. 16 gauge 12" X 12" X 8" wallbox with 16 gauge 12" X 12" flush access door with concealed hinge and stainless steel screwdriver operated cam latch and with a 7" X 7" bulkhead mounted within the box to accept camera cable connectors.

C. Outdoor ITV AV wallbox
   1. 16 gauge 12" X 12" X 8" weatherized box with 7" X 7" bulkhead mounted within the box to accept camera cable connectors.

D. TV Truck Location ITV AV wallbox
   1. 16 gauge 12" X 26" X 8" weatherized box with 8" X 22" bulkhead mounted within the box to accept camera cable connectors.

E. Triaxial cable and connectors
   1. Triax cable Belden 1859A
   2. Triax connector camera location Kings triax female jack 7703-8
   3. I/O panel, near production truck- Kings triax, front mount, male plug 7705-6

F. Video cable and connectors.
   1. Belen 1695A RG6 cable
   2. BNC connectors Amphenol Conex BNC crimp jack 112965 female connection that fits on the end of the 1695A cable itself at the camera location.
   3. BNC connectors Amphenol Conex BNC crimp jack 112662 female connection that fits on the I/O panel located near the production truck.
   4. Crimp tools to be utilized:
      a. Amphenol Conex crimp tool model #47-10110 which includes die #47-20001
      b. Amphenol Conex die:
         1) For the Amphenol Conex BNC crimp jack 112965 ferrule : 324" and contact : .042
         2) For the Amphenol Conex BNC crimp jack 112662 ferrule : 324" and contact : .068

G. Audio cable and connectors
   1. Audio cable Belden 1801B analog and digital rated XLR cable
   2. XLR connectors Neutrik NC3FXX-EMC, 3 pole female EMC-XLR cable connector used at the camera locations.
   3. XLR connectors Neutrik NC3MD-LX, 3 pole male receptacle, solder cups, nickel housing, silver contacts. Utilized on the on the I/O panel located near the production truck.
   4. SCM, dust protection cover for male chassis connectors. Provide for each male XLR connector.

2.15 TUBE CABLES AND HARDWARE

A. Manufacturer: Subject to compliance with requirements, provide products by Sumitomo FutureFLEX®.

B. All indoor tube cables shall be composed of dielectric materials and rated Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for Communications, Plenum Rated: Type CMP, complying with NFPA 262

C. Four (4) Tube Bundle Indoor Cable between MDF and IDF's. Sumitomo TC04TRX.

D. Seven (7) Tube Bundle Indoor Cable between MDF and IDF's. Sumitomo TC07TRX.

E. Nineteen (19) Tube Bundle Indoor Cable between MDF and IDF's. Sumitomo TC19TRX.

F. Nineteen (19) Tube Bundle Outdoor Rated Cable between the Bioscience Education Building MDF and other the SA Buildings. Sumitomo TC19MSOS.
   1. All outdoor tube cables shall be composed of dielectric materials and be outside plant rated.

G. All Tube Distribution Units (NEMA rated per application), tube-splice enclosures/Tube Splice Cases/cold-shrink closures per manufacturer's recommendations.

H. Single clear tube between distribution unit and rack mounted fiber box. Sumitomo TC01TCX.

2.16 TUBE DISTRIBUTION UNITS

A. A NEMA-rated enclosure, suitable for the site environmental conditions (i.e. NEMA 1 for indoor use) shall be provided for tube distribution, routing, and termination.

B. The contractor is responsible for selecting the Tube Distribution Units hardware to meet site conditions.

C. Tube Distribution Units shall be wall mounted in the TR where tubes are spliced.

D. Tube Distribution Unit is Sumitomo DE12IDU.

2.17 OPTICAL FIBER CABLE

A. Manufacturer: Subject to compliance with requirements, provide products by Sumitomo FutureFLEX®.

A. Fiber bundles shall be installed end to end or "home run" from EF/MC to TR/HC, or any designated area to receive tube cable infrastructure.

B. Zero tensile stress shall be placed upon the fiber bundles during installation to eliminate micro-fractures within the glass.

C. Riser optical fiber description: 24 strands of Multimode 50/125µm optical fiber, shall have the following specifications:
   1. Dual window, 850 nm and 1300 nm

2. Minimum Overfilled Launch Bandwidth – 500 MHz-km at 850 nm, 500 MHz-km at 1300 nm.
3. Maximum attenuation – 3.5 dB/km at 850 nm, 1.5 dB/km at 1300 nm.
4. Gigabit bandwidth – 500 MHz-km at 850 nm, 500MHz km at 1300 nm
5. Gigabit Ethernet Distances – 550m at 850 nm, 550m at 1300 nm
6. 10-Gigabit Ethernet Bandwidth – 1500MHz at 850nm, 500 MHZ at 1300nm
7. Riser optical fiber to be Sumitomo FB24G53.

D. Outside plant optical fiber description: 18 stand Singlemode optical fiber, shall have the following specifications:
1. Dual window, 1310 nm and 1550 nm.
2. Maximum attenuation – 0.40 dB/km at 1310 nm, 0.30 dB/km at 1550 nm.
3. Dispersion unshifted, matched-clad, zero water peak.
4. Outside plant optical fiber to be Sumitomo FB18SX

2.18 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by Molex Premise

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, simplex and duplex cable connectors.
1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
2. Fiber Optic enclosures shall be 96-Strand rack mountable enclosures with accommodations for splice trays. Fiber Optic enclosures shall be Molex RFR-00202
3. Fusion splice tray as needed for transition point and factory terminated pigtails.
4. SC duplex 12 fibers coupler panels shall be used for Multimode fiber. Molex AFR-00191
5. SC duplex 12 fibers coupler panels shall be used for Single Mode Fiber. Molex AFR-00192
6. Size fiber enclosure for 25% percent spare capacity.

C. Patch Cords: Factory-made, dual-fiber cables in one (1) meter lengths. Supply SC - to - SC duplex for one-half of the total termination points.
1. Coordinate final connector type with owner.

D. Patch Cords: Factory-made, dual-fiber cables in three (3) meter lengths. Supply SC – to - SC duplex for one-half of the total termination points.
1. Coordinate final connector type with owner.

E. Cable Connecting Hardware:
1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Multi mode connectors type SC.
3. Single mode connectors type SC.
4. Connectors for Multimode and Singlemode shall be factory terminated pigtail assemblies for field installation via fusion splicing.

2.19 CABLE LUBRICANT

A. Cable pulling lubricant, Product: Ideal Yellow 77 or approved equal, shall be utilized when pulling cable.

2.20 FIRE STOP CABLE PASS-THRU SLEEVES

A. Fire Rated Cable Pathways: STI EZ-PATH MAX™ Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
   1. Specified Technologies Inc. (STI) EZ-PATH MAX™ Fire Rated Pathway
   2. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway

B. Horizontal cable pathway locations greater then 20 cables fire stop sleeves shall be STI EZ-Path.

C. Horizontal cable pathway locations fewer than 20 cables EMT sleeve with UL listed system for firestopping is acceptable. Caulks and sealants shall be as manufactured by STI, 3M, Nelson, or approved equivalent.

D. Fire stop sleeves located in the floor of each TR shall be quantity as shown on contract drawings STI EZ-path MAX/EZD44 cast in concrete.

E. Fill ratio for fire stop EMT sleeves is based on a not to exceed 40% fill capacity.

2.21 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.22 LADDER RACK, SUPPORTS, AND ACCESSORIES

A. Ladder Rack (Universal Cable Runway)
   1. Ladder rack shall be manufactured from 3/8” wide by 1-1/2” high tubular steel with .065” wall thickness.
   2. Ladder rack (side stringers) will be 9’-11½” long. Cross members will be welded in between stringers on 12” centers beginning 5-3/4” from one end so that there are 10 cross members per ladder rack. There will be 10-1/2” of open space in between each cross member.
   3. Ladder rack will be delivered individually boxed, and available in the multiple widths.
   4. Finish shall be epoxy-polyester hybrid powder coat (paint) black in color.
   5. Design Make: Chatsworth Products, Inc. (CPI), Universal Cable Runway: Part Number 10250-712, Universal Cable Runway, 12” Wide, Black 10250-718, Universal Cable Runway, 18” Wide, Black or approved equal.
   6. Design Make: Chatsworth Products, Inc. (CPI), Universal Cable Runway: Part Number 10250-724, Universal Cable Runway, 24” Wide, Black placed in vertical positions or approved equal.

B. Ladder Rack Splices

1. Splice kits will provide a method of mechanically connecting ladder rack sections and turns together end-to-end or side-to-end to form a continuous pathway for cables.
2. Grounding kits will provide a method of bonding ladder rack sections and turns together that is independent of the pathway splices. The grounding kit should be constructed of UL Listed components. The preferred solution is a #6 AWG green insulated stranded copper conductor connected on both ends to ladder rack using two-hole compression lugs and stainless steel hardware.
3. Splices (splice plates) will be manufactured from steel. Splice, grounding and insulator bar kits will include installation hardware.
4. Finish (of splice plates and hardware) shall be zinc plate in the color(s) specified below. Colors are applied as a chem. film over the zinc plate.
5. Design Make: Chatsworth Products, Inc. (CPI), Cable Runway Splices or approved equal.

C. Ladder Rack Supports

1. Supports will be sized to match the width of the ladder rack that is supported. Some supports will work with all widths of ladder rack.
2. Each support will include a means of securing ladder rack to the support.
3. Supports will be manufactured from steel or aluminum.
4. Finish shall be epoxy-polyester hybrid powder coat (paint) in the color(s) specified below or zinc plate with a gold chem. finish specified gold. Included hardware shall be zinc plated with a gold chem. finish.
5. Design Make: Chatsworth Products, Inc. (CPI), Cable Runway Supports or approved equal.

D. Ladder Rack Accessories

1. Cable straps used for attaching cable bundles to the ladder rack cross members must be reusable with a hook and loop-style closure, at least ¾" wide, and sized for cable bundles that are 2", 3" or 4" in diameter.
2. Cable retaining posts used to keep cable from falling off of the side of the ladder rack shall be manufactured from 1" by ½" tubular steel with .065" wall thickness. Cable retaining posts will be 8" high and will attach to the side stringer of the ladder rack with included hardware. The top of the cable retaining posts will be fitted with a rubberized end cap to protect cables.
3. End caps used to cover the ends of ladder rack will be manufactured from a black fire-retardant rubberized material. End caps will be sized for 3/8" wide by 1-1/2" high side stingers and will be sold in pairs.
4. End closing kits used to cover the end of ladder rack will be manufactured from 3/8" wide by 1-1/2" high tubular steel with .065" wall thickness. Kits will consist of a bar cut to match the width of the ladder rack and the hardware required to attach the bar to the end of a length of ladder rack.
5. Radius drops used to create a radius to form cables over as the cables exit or enter the ladder rack will be manufactured from aluminum extrusion. The extrusion will be formed in a 90° arc with a minimum bend radius of 3". Radius drops will attach to either the side stringer or the cross member of the ladder rack using a clevis pin. Radius drops will include 1-1/2" high cable spools that attach to the top of the radius drop to guide cables.
6. Movable cross members used to support cross member radius drops in between welded cross members on ladder rack will be manufactured from 3/8" by 1-1/2" aluminum bar. Movable cross members will attach to ladder rack at the side stringers with included hardware so that the location of the movable cross member can be adjusted. Moveable cross member will support a cross member radius drop.
7. Cable spools used to separate ladder rack into multiple cable pathways will be made from a black flame retardant ABS. Cable spools will attach to the cross members with a clip that allows the width of the ladder rack to be divided into any proportion. The spools will be 3.94" tall, with a 1.94" diameter top, and a body that tapers from .88" (diameter) at the top to .62" (diameter) at the bottom.

8. Auxiliary support brackets used to support cables that should be physically separated from the cables in the ladder rack will be made from 1/8" x 1" steel bar. The bracket will be L-shaped and will attach to the side stringer of the ladder rack. The bracket will hang below the ladder rack a minimum of 4". The bracket support surface will be 4" long. The bracket will be zinc plated with a gold chem. finish.
9. Touch-up paint used on ladder rack and ladder rack system components will be color-matched to the finish on the ladder rack or component. A spray on and brush on option will be available.
10. Unless otherwise noted, finish on all metal components shall be epoxy-polyester hybrid powder coat (paint) black in color. Hardware will be zinc plated with a gold chem. finish.
11. Design Make: Chatsworth Products, Inc. (CPI), Cable Runway Accessories or approved equal.

2.23 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches A-C Grade.

B. All 4 walls shall be covered with rigidly fixed 3/4 inch A-C plywood with the A grade side facing outward. The plywood shall be void free and extend from 6 inches above the finished floor (AFF) to 102 inches AFF and capable of supporting the attached equipment.

2.24 EQUIPMENT FRAMES

A. Free Standing Relay Racks
1. Manufacturer: Chatsworth Products, Inc. (CPI).
2. Racks shall be manufactured from aluminum and/or steel extrusions.
3. Ladder Racks shall be bolted to the equipment racks for added stability.
4. Each rack will have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment-mounting channels. The rack will assemble with bolt hardware. Equipment-mounting channels will be threaded for easy assembly. The base angles will be pre-punched for attachment to the floor.
5. Equipment mounting channels will be 3" deep and punched on the front and rear flange with the EIA-310-D Universal hole pattern to provide 45 rack-mount spaces for equipment. Each mounting space will be marked and numbered on the mounting channel in blue.
6. When assembled with top and bottom angles, equipment-mounting channels will be spaced to allow attachment of 19" EIA rack-mount equipment. Attachment points will be threaded with 12-24 roll-formed threads. The rack will include assembly and equipment-mounting hardware. Each rack will include 50 each combination pan head, pilot point mounting screws.
7. The assembled rack will measure 7' (84") high, 20.3" wide and 15" deep. The sides (webs) of the equipment-mounting channels will be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying.
8. The rack will be rated for 1,500 lb. of equipment.
9. The rack will be UL Listed.
10. Finish shall be epoxy-polyester hybrid powder coat black in color.
11. Design Make: Chatsworth Products, Inc. (CPI), Universal Self-Support Rack or approved equal.

2.25 CABLE MANAGEMENT

A. Vertical Cable Management for Racks.

1. Manufacturer: Chatsworth Products, Inc. (CPI).
2. Every rack will have a minimum of one vertical cable manager. The vertical cable manager will create a space for storing and organizing cables along the side of the rack/frame. The cable manager will maintain separation between patch/equipment/jumper cords and premise cables. The last rack in a row shall have two vertical cable managers.
3. The cable manager will be sized to match cabling requirements and to fit the rack/frame or as specified. The initial quantity of cables within the cable manager will not exceed a whole number value equal to 40% of the interior area of the cable manager.
4. A single vertical cable manager can be used in between bayed racks/frames if it is sized to match cable requirements for both racks/frames. The manufacturer will state estimated cable fills for the cable manager in the product data sheet.
5. The vertical cable manager will match the height of the rack(s)/frame(s).
6. The vertical cable manager will bolt to the side of racks/frames with included hardware. The manufacturer of the vertical cable manager will sell compatible racks/frames.
7. The vertical cable manager will be a double-sided H-shaped trough with a front cover and evenly spaced spin-open latches on the rear side. The double-sided trough will provide independent front and rear cable pathways and will have multiple evenly-spaced edge-protected front-to-rear cable pass-through holes for cables in the center divider.
8. The front cover will be removable, hinged to open from the right or left side and will include a latch that will secure the cover in the closed position. The rear will be mostly open with multiple evenly spaced spin-open latches.
9. The front of the vertical cable manager will have cable openings along both sides of the trough. The openings will be formed by evenly-spaced T-shaped cable guides. The T-shaped cable guides will be made from a composite plastic material (not metal) and will have rounded edges to protect cables. When the cable manager is attached to a rack/frame, each cable opening will align with a rack-mount space (RMU) on the rack/frame. Each opening will pass a minimum of 24 each .25" OD patch cords.
10. The cable manager will be delivered individually boxed, and available in several widths as specified below and in the contract documents.
11. The vertical cable manager shall be manufactured from sheet aluminum and composite materials.
12. Finish shall be epoxy-polyester hybrid powder coat paint in the color as specified below and in the contract documents. Edge-protectors, T-shaped cable guides and latch hardware is black.
13. Design Make: Chatsworth Products, Inc. (CPI): CCS Combination Cabling Section: Part Number Part Number 30095-703 CSC, MCS Master Cabling Section, Double-Sided, 6" Wide x 84" High x 8.1"D, Black.

B. Horizontal Cable Management for Racks, Frames or Cabinets

1. Place horizontal cable managers above and below each patch panel in each rack/cabinet. The horizontal cable manager will guide patch/equipment cords between the vertical cable manager and individual network port connections.
2. Provide 2 RMU of horizontal cable management above and below every patch panel. Cables must be able to access the cable manager so that no ports are blocked by the cables.
3. The manufacturer will state estimated cable fills for the cable manager in the product data sheet.
4. The horizontal cable manager will match the rack-mount width of the racks/cabinets.
5. The horizontal cable manager will attach to the front or rear of the rack/frame/cabinet with screws and will be sized to fit within standard EIA-310-D (1-3/4" high RMU) rack-mount spacing. The manufacturer of the horizontal cable manager will sell compatible racks/cabinets.
6. The horizontal cable manager will be a single-sided C-shaped trough with a cover. The single-sided trough will have a slot or holes at the rear to facilitate front-to-rear cabling through the horizontal manager. The front of the cable manager will have T-shaped cable

guides along the top and bottom surfaces of the cable manager. Evenly spaced cable openings in between the T-shaped cable guides will allow cables to enter/exit the cable manager into the rack-mount space. The openings will have rounded edges to protect cables. The cover will be removable, hinged to open up or down and will snap on to secure the cover in the closed position.

7. The horizontal cable manager will be delivered individually boxed, and available in several widths and heights as specified below and in the contract documents.
8. The horizontal cable manager shall be manufactured from sheet aluminum and composite materials.
9. Finish shall be epoxy-polyester hybrid powder coat paint in the color as specified below and in the contract documents. Edge-protectors, T-shaped cable guides and latch hardware is black.
10. Design Make: Molex 25.B013G 2U Ring Run.

2.26 POWER STRIPS

A. Each equipment rack is to contain a 20 amp rack mounted power distribution panel that is to occupy the first rack space in each rack.

B. Power distribution panels shall be: Chatsworth 12816-707.

2.27 IP INTERCOM

A. Wall mounted stainless steel intercom station: Aiphone IE-JA.

B. Network intercom adaptor: Aiphone IPW-1A.

2.28 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Electrical Identification."

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

B. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

C. Install pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.

1. Install entrance pathway complying with Division 26 Section "Raceways and Boxes."

3.2 INSTALLATION OF PATHWAYS

A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Division 26 Section "Raceways and Boxes" for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows whenever possible.

D. Pathway Installation in Communications Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard when entering room from overhead.
   4. Extend conduits 3 inches (76 mm) above finished floor.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 NON-CONTINUOUS CABLE SUPPORTS

A. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.

B. Do not exceed load ratings specified by manufacturer.

C. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.

D. Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.

3.4 WIRING METHODS

A. Wiring Method: Install cables in raceways, J hooks, and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables accessible ceilings, walls, and floors except in unfinished spaces.

B. Install plenum cable in environmental air spaces, including plenum ceilings.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

E. Provide equipment frames and ladder racking as outlined in telecommunications series drawings.

3.5 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. All cable runs must maintain 10-foot long service loops on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
3. Terminate patch panels and outlets to a pin/pair assignment 568B.
4. Use blue sheathed cable for data drops, white sheathed cable for voice drops, and grey sheathed cable for MCFNET drops.
5. MCFNET Outlets are used for Building Automation Systems Emergency Notification System, Security Cameras and Video Conferencing Codices. Confirm locations of these outlets with the Owner prior to installation.

D. UTP Riser Cable Installation:
1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
3. Terminate patch panels to a pin/pair assignment as directed by owner.

E. UTP Patch Cords
1. Provide modular cords required to connect LAN switches to modular jacks on cross connect panel shall be furnished as part of this solicitation. Quantities should be equal to the total number of network outlets at the patch panel. At the Patch panel location provide patch cable lengths as needed for a neat installation utilizing vertical wire managers.
2. At the user outlets provide 10 foot patch cables for each 8 pin modular connector

F. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 10 feet long not less than 12 inches in diameter below each feed point.

H. Group connecting hardware for cables into separate logical fields.

I. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
3. Fiber shall be installed in innerduct within conduits.
4. Multiple fibers shall be pulled in the same innerduct whenever possible.
5. Fiber shall be installed in one continuous piece.
6. Any excess fiber shall be coiled neatly and secured to a wall above the plywood backboard so it is out of the way of normal traffic and is not subject to unusual flexing.

J. Outdoor Coaxial Cable Installation:
1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).

K. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.6 TUBE CABLE INSTALLATION

A. Prior to pulling tube cable, thoroughly swab conduits to remove foreign material before pulling cables.

B. Furnish all required installation tools to facilitate Tube Cable installation without damage to the cable jacket. Such equipment is to include, but not be limited to, sheaves, winches, cable reels, cable reel jackets, duct entrance funnels, pulling tension gauges, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices that may move or wear in a manner to pose a hazard to the cable shall not be used.

C. Tube Cable pulling shall be done in accordance with cable manufacturer's recommended procedures and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions and minimum bending radii shall not be exceeded. Any tube cable bent or kinked to a radius less than recommended (20 times the radius during installation and 10 times the radius after installation) shall not be installed.

D. During tube cable pulling operation, an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.

E. During installation, tube cable ends are to be completely sealed per manufacturer's recommended procedures to prevent ingress of contaminants.

F. All unoccupied tubes shall be plugged on both ends per manufacturer's specifications.

G. Upon completion of tube cable installation, all tubes shall pass the standard 150 psi pressure test and 5 mm bead obstruction test per the cable manufacturer's recommended procedures.

H. TDUs shall be installed as shown in the drawings, wherever several cables enter the same location or where tube cable type transitions take place.

I. Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable material used. Lubricant shall not harden or become adhesive with age.

J. Avoid abrasion and other damage to cables during installation.

K. Tube Cable slack is required for thermal expansion/contraction per manufacturer's recommendations.

L. All exposed tube cable shall be labeled at 35-foot (maximum) intervals with tags indicating ownership, cable type, and fiber type installed.

M. Tube cable shall be riser or plenum-rated if required by the installation environment.

N. Where not installed in a continuous length, tube cable segments shall be spliced using couplings designed for that purpose and housed within a properly rated TDU (tube distribution unit), splice case, or cold shrink wrap per manufacturer's specifications.

O. Conductive material(s) shall be bonded and grounded per ANSI/TIA/EIA-J Std-607.

P. Upon completion of tube cable installation, all tubes shall pass the standard 150 psi pressure test and 5 mm bead obstruction test per the cable manufacturer's recommended procedures.

Q. Tube splice connections shall only be done in tube distribution units.

R. Tube splice configuration shall be as shown on contract drawings.

3.7 FIBER BUNDLE INSTALLATION

A. Reusable, PEF jacketed (Polyethylene Extruded Foam), fiber bundles shall be installed according to manufacturer's recommended procedures.

B. PEF jacketed optical fiber cable bundles shall be continuously inserted and propelled or blown into the individual tubes utilizing compressed nitrogen as the propellant per the manufacturer's instructions. The blowing installation process and the fiber bundles must also be designed to allow removal, replacement, and reuse of the fiber bundles at any time in the future as deemed necessary by the owner.

C. Slack in each PEF jacketed fiber bundle shall be provided as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1 meter (39") of slack shall be retained at the work area, and a minimum of 3 meters (approximately 10') of slack shall be retained in equipment rooms and telecommunications rooms.

D. Qualified, licensed personnel utilizing state-of-the-art equipment and techniques shall complete all optical fiber terminations.

3.8 TUBE CABLE TESTS

A. The contractor shall provide to the Owner's Representative, obstruction and pressure test data for each tube installed. Both pressure and obstruction tests shall be completed prior to installing fiber bundle(s)

B. Pressure testing is required for testing end-to-end tube spans after completion of tube cable installation and tube inter-connection.

C. Tube pressure testing shall be completed before proceeding with end-to-end tube obstruction testing.

D. Obstruction testing shall be performed on all tubes upon completion of tube cable installation and prior to fiber bundle installation.

3.9 INSTALLATION TELECOMMUNICATIONS ROOMS

A. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

B. Bond the shield of any shielded cable to the grounding bus bar in communications rooms and spaces.

C. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

D. Power Requirements for Racked Electronics:
   1. Each MDF/IDF requires two (2) each 220 volt, 30 amp DEDICATED circuits terminated in an L630R receptacle on unistrut at 18" AFF adjacent to equipment racks.

E. Free Standing Relay Racks
   1. Assemble relay racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
   2. All racks must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below. (Use CPI Part Number 40604-003 for concrete slab floors.)
   3. Racks shall be grounded to the TGB using appropriate hardware. The ground will meet local code requirements and will be approved by the Authority Having Jurisdiction (AHJ).
   4. Ladder rack shall be attached to the top of the racks/cabinets to deliver cables to the rack. The rack should not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.
   5. The equipment load should be evenly distributed and uniform on the rack/cabinets. Place large and heavy equipment towards the bottom of the racks/cabinets. Secure all equipment to the racks/cabinets with equipment mounting screws.

F. Ladder Rack
   1. Provide all components of the ladder rack system (ladder rack, turns, splices, supports, and accessories) from a single manufacturer.
   2. Ladder rack shall be installed with side stringers facing down so that the ladder forms an inverted U-shape and so that welds between the stringers (sides) and cross members (middle) face away from cables.
   3. Ladder rack shall be secured to the structural ceiling, building truss system, wall, floor or the tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).
   4. Ladder rack splices will be made in mid-span, not over a support, with the manufacturer's recommended splice hardware.
   5. Ladder rack shall be supported every 5' or less in accordance with TIA-569-B. Ladder rack shall be supported within 2' of every splice and within 2' on both/all sides of every intersection. Support ladder rack within 2' on both sides of every change in elevation. Support ladder rack every 2' when attached vertically to a wall.
   6. Heavy-duty splices are recommended for ladder rack in excess of 18" width (18" wide ladder rack). Heavy-duty splices are required for any splice formed in the vertical orientation including changes in elevation formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns. Use heavy-duty splices to secure all overhead turns to the overhead horizontal pathway(s).
   7. When the pathway is overhead, ladder rack shall be installed with a minimum clearance of 12" above the ladder rack. Leave a minimum of 12" in between ladder rack and ceiling/building truss structure. Leave a minimum of 3" in between ladder rack and the

tops of equipment racks and/or cabinets. Multiple tiers of ladder rack shall be installed with a minimum clearance of 12" in between each tier of ladder rack. When located above an acoustical drop ceiling, leave a minimum of 3" clearance between the top of the drop ceiling tiles and the bottom of the ladder rack.

8. When installed under a raised floor, ladder rack shall be installed with a minimum 3" clearance between the top of the ladder rack and the bottom of the floor tiles or floor system stringers, whichever is lower in elevation. Maintain a 3" clearance between ladder racks wherever ladder racks cross.
9. Within each telecommunications room, ladder rack should be bonded together, electrically continuous, and bonded to the TGB, unless otherwise noted in the specifications and contract documents. Ladder rack and turns shall be bonded across each splice with a bonding kit. Ladder rack shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the ladder rack and a minimum #6 grounding wire or as recommended by the AHJ. Remove paint from the ladder rack where bonding/ground lugs contact the ladder rack so that the lug will contact bare metal. Use antioxidant joint compound in between the bare metal on the ladder rack and ground lug. Use antioxidant joint compound in between the bus bar and the ground lug. Verify continuity through the bonds at splices and intersections between individual ladder rack sections and turns and through the bond to the TGB.
10. The quantity of cables within the ladder rack will not exceed a whole number value equal to 50% of the interior area of the ladder rack divided by the cross-sectional area of the cable. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2", unless cable retaining posts are added to the ladder rack. The interior area of ladder rack equipped with cable retaining posts will be considered to be the width of the ladder rack multiplied by a height of 6". Actual cable fill for ladder rack that is not equipped with cable retaining posts will not exceed 2" in height. Actual cable fill for ladder rack equipped with cable retaining posts will not exceed 6" in height.
11. The combined weight of cables within the ladder rack will not exceed the stated load capacity of the ladder rack as stated in the manufacturer's product specifications or load/design tables.
12. Cables (cable bundles) will be secured to the cross members of ladder rack with ¾" wide reusable straps. Straps are not required when ladder rack is equipped with cable retaining posts.
13. Add 8" high cable retaining posts to the open sides of ladder rack when cable fill exceeds 2" in height or when cable bundles cannot be secured directly to the ladder rack cross members with a strap. Cable fill within any ladder rack should not exceed 6" in height.
14. When a single ladder rack supports different types of cable media, the cable media will be separated within the pathway by cable spools that attach to the cross members on the ladder rack. Treat each type of cable media and divided area of the ladder rack separately when determining cable fill limits.
15. Use a radius drop to guide cables wherever cable exits overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field. If necessary, provide a moveable cross member also to attach and align the radius drop in between the welded cross members of a ladder rack.
16. Cover the exposed ends of cable runway that do not terminate against a wall, the floor or the ceiling with end caps or an end closing kit.
17. Use auxiliary support brackets that attach to the side stringer of the ladder rack to support interconnect cabling (patch cords, equipment cords, jumper cords) that is routed between racks using the ladder rack. Auxiliary support brackets can be used to support other conductors that should be physically separated from cables within the ladder rack as defined by local code or the authority having jurisdiction (AHJ).
18. Whenever possible, maintain a 2' separation between ladder rack used for communications cables and pathways for other utilities or building services.
19. Provide touch-up paint color-matched to the finish on the ladder rack and correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling

during the installation process prior to delivery. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, the component will be replaced with a new component finished from the factory. If a component is physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the ladder rack system.

G. Vertical Cable Managers
1. Attach vertical cable managers to the side of the rack/frame using the manufacturer's installation instructions and included hardware.
2. When a single vertical cable manager is used in between two racks, attach the vertical cable manager to both racks.
3. When more than one cable manager is used on a rack or group of racks, use the same make, style and size of vertical cable manager on the rack or in between racks.
4. The color of the racks and cable managers must match.
5. Doors should be attached to the cable manager and in the closed position after cabling is complete.

H. Horizontal Cable Managers
1. When more than one horizontal cable manager is used on a rack/cabinet or group of racks/cabinets, use the same make, and style of cable manager on the rack/cabinet or racks/cabinets.
2. The color of the racks and cable managers must match.
3. Attach horizontal cable managers to the rack/cabinet with four screws according to the manufacturer's installation instructions. Each cable manager should be centered within the allocated rack-mount space (RMU).
4. Horizontal managers will be located so that the number of ports (cables) they support will not exceed the cable fill capacity of the cable manager.
5. Covers should be attached to the cable manager and in the closed position after cabling is complete.

3.10 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

D. Any penetrations created for the passage of telecommunications which remains vacant at the completion of the installation shall be fire stopped.

E. Install fire stop units as per manufactures Instructions.

3.11 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with requirements in division 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

C. Comply with ANSI-J-STD-607-A.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.12 VIDEO SYSTEM INSTALLATION - BUILDING INTERIOR

A. Provide video/CATV system engineering depicting device location, device type, backbone cable paths and per outlet db loss calculations for Owner approval before the beginning of installation of any video system cable or equipment. NOTE: A home run approach to feeding user outlets is desirable for this project.

B. Install RF modulator with sub-band option and a video diplexer in a rack in MC room to allow for retransmission of sub-band frequency programming that can originate in classroom spaces via the RF video coaxial cabling system. Product: (1) portable RF modulator on castered Bretford castered cart with power distribution to originate remote (sub-band) AV signals at RF video outlet locations.

C. Amplifiers shall be mounted using four (4) screws.

D. Active and/or passive devices in an individual telecommunications closet shall be connected using chassis-to-chassis or right angle connectors.

E. Directional couplers shall be secured to plywood with four (4) 1-3/16" screws. This does not apply to Directional couplers attached to amplifiers.

F. The directional couplers attached to amplifiers shall face either left or right, but not outward into the telecommunications closet. Unused ports shall be terminated.

G. The RG-6 station cable shall be supported every sixty (60) inches, and clearly indicate the jack and room number of the station end in indelible ink written on plastic cable tags attached to both ends of the cable.

H. Connectors shall be chosen and installed so they can withstand thirty (30) pounds of pulling force without separating from the cable. The co-axial station cables will route from the backbone riser cable to vertical conduits "stubbed out" above each telecommunications cable raceway, floor or w outlet location. Pull the co-axial cable through the vertical conduit to the RF video workbox. At the aforementioned workbox, terminate the RF video cable to a pre-approved faceplate.

3.13 VIDEO SYSTEM ADJUSTING

A. Adjust amplifier gain and make other system adjustments to achieve specified output levels (+3-6db range) at each outlet. Provide riser drawing with db loss calculations for approval prior to any RF video cable installation.

3.14 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

B. Coordinate labeling scheme with Owner prior to installation.

C. Comply with requirements in Division 9 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish four (4) copies and an electronic copy of a cable cut sheet identifying each cable as run and labeled to every room and outlet.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
   1. Provide four (4) bound copies, one (1) electronic copy in AutoCAD.dxf format, and one (1) electronic copy in Adobe.pdf format of "As Built" drawings identifying each cable as installed and labeled to every room and every outlet.
   2. Drawings shall include:
      a. All IDF, MDF, and Equipment rooms with plan and elevation views of each.
      b. Show major pathways of cable runs, wall penetrations, and locations of conduit pull boxes
      c. The location of all cable terminations
      d. The location of all backbone cables
      e. The jack number shall appear on the drawing
      f. The location of all telecommunications outlets on the floor plans

F. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Vertical and backbone cables shall be labeled on each end.
   3. Horizontal cable shall be labeled on the patch panel and the jack in addition to the labels on the cable itself.
   4. Each cable should have a unique identifier.
   5. Label cables and conduits at strategic locations such as conduit ends, backbone splice points, manholes and pull boxes
   6. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.
   7. Horizontal cable labels shall include the following information:
      a. Building Code
      b. Room Number
      c. Closet Number
      d. Rack Number
      e. Panel Number
      f. Port Number (sequential incremented per room)
   8. Tube Cable labeling
      a. Each core cable is given a unique designator. Coordinate with Owner.
      b. Each tube within a tube cable is numbered sequentially starting at one. Both ends of the tubes at all splice points, must be labeled identically.
   9. Riser optical fiber cable labels shall include the following information:
      a. Building code

b. Closet room number
c. Rack number
d. Fiber shelf number

10. Backbone optical fiber cable labels shall be labels at both ends with the termination information of the other end of the cable. Labels shall include the following information:
    a. Building code
    b. Closet room number
    c. Rack number
    d. Fiber shelf number

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
1. The identifier shall be on a label affixed to the cable
2. Cables use flexible vinyl or polyester for labels that flex as cables are bent.
3. Labels shall be consistent across the installation.

3.15 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.16 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Visually inspect UTP, multi-pair copper and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm cable category marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. Optical Fiber Cable Tests:
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:
      1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
      2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
      3) Cables shall pass or exceed testing standards as outlined by Montgomery Community College Cable Standards.
6. UTP Performance Tests:
   a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
      1) Wire map.
      2) Length (physical vs. electrical, and length requirements).
      3) Insertion loss.
      4) Near-end crosstalk (NEXT) loss.
      5) Power sum near-end crosstalk (PSNEXT) loss.
      6) Equal-level far-end crosstalk (ELFEXT).
      7) Power sum equal-level far-end crosstalk (PSELFEXT).
      8) Return loss.
      9) Propagation delay.
      10) Delay skew.
      11) Cables shall pass or exceed testing standards as outlined by Montgomery Community College Cable Standards.
7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
8. Coaxial cable and video signal testing shall be performed in the following manner to verify correct installation of coaxial cable and video system electronics:
   a. Input Signal @ 450 MHz Output Output @ chi. 7
   b. (after pad & equalizer) @450 MHz (175.2 MHz) +6 dBmv (+/- 1 dbmv) +40 dBmv after amplifier (+/- 5dbmv)
   c. The output of directional couplers and FFTs shall be at least +9 dBmv.
9. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.
   a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
   b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

3.17 DEMONSTRATION

A. Provide eight (8) hours of training to owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

3.18 REPAIR/RESTORATION

A. Protect adjacent surfaces. Repair damage to any surfaces occurring as a result of the work of this Section. Repair of surfaces shall include re-painting in accordance with Division 09 Section "Painting."

3.19 CLEANING

A. At the completion of the System, restore aspects of the project site to its former condition. Remove daily waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract. Remove trash from all work areas. Do not use dumpsters or trash disposal without prior approval.

END OF SECTION 27 00 00

SECTION 270526

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Grounding/Earthing and bonding for Low Voltage systems such as telecommunications and audiovisual systems.
   2. Telecommunications Grounding Busbar (TGB)
   3. Telecommunications Main Grounding Busbar (TMGB)
   4. Telecommunications Bonding Backbone (TBB)
   5. Rack Grounding/Earthing and Bonding
   6. Pathways.

B. Related Sections:
   1. Division 26 Section *Grounding and Bonding* for building systems with which to interface with Work of this Section.

1.2 DEFINITIONS

A. AFC: Above Finished Ceiling

B. BICSI: Building Industry Consulting Service International.

C. Bonding: Permanent joining of metallic parts to form an electrically conductive path to ensure electrical continuity and capacity to safely conduct current.

D. Common Bonding Network (CBN) – The principal means for affecting bonding and earthing inside a building.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. Ground/Earth – A conducting connection, whether intentional or incidental, by which an electric circuit or equipment is connected to ground, or to some conducting body of relatively large extent that serves in place of the ground.

H. HC: Horizontal Cross Connect

I. IDC: Insulation displacement connector.

J. LAN: Local Area Network.

K. MC: Main Cross-connect

L. NEBS: Network Equipment Building System.
   1. NEBS Level 3: Equipment complies with strict specifications for fire suppression, thermal margin testing, vibration resistance including seismic, airflow patterns, acoustic limits, failover and partial operational requirements such as chassis fan failures, failure severity levels, RF emissions and tolerances, and testing/certification requirements.

M. NEC: National Electric Code

N. RCDD: Registered Communications Distribution Designer.

O. TR: Telecommunications Room

P. UTP: Unshielded twisted pair.

1.3 SYSTEM DESCRIPTION

A. Purpose: Telecommunications grounding/earthing system creates a low impedance path to earth ground to prevent damage to equipment and disruption in service due to electrical surges and transient voltages.

B. Grounding/earthing system comply with following:
   1. NEC and local electrical codes
   2. ANSI/TIA-942 and J-STD-607-A.

C. Telecommunications Grounding Busbar (TGB): Ground/earth each telecommunications space to the Telecommunications Main Grounding Busbar (TMGB) located at the service entrance.

1.4 SUBMITTALS

A. Comply with Division 01 33 00 Section *Submittal Procedures*.

B. Product Data: Submit for each type of product specified.

C. Shop Drawings: Submit following:
   1. Cabling administration drawings and printouts.
   2. Wiring diagrams to show grounding schematics, including the following: Busbars and bonding backbone. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

D. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

E. Pre-Qualification Certificate: Submit a letter of approval from the manufacture indicating compliance with qualification requirements. Training certificates for design, engineering and installation of the proposed products shall be submitted with the proposal.

F. Closeout Submittals: As part of Operation and Maintenance Manuals, submit copies of delivery tickets including listings of part numbers and quantities delivered for use on this project.

G. Source quality-control reports.

H. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements, grounding/earthing and bonding systems:
   1. TIA/EIA
      a. TIA-942 Telecommunications Infrastructure Standard for Data Centers
      b. J-STD-607-A Commercial Building Grounding/Bonding Requirements
      c. TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   2. IEEE
      a. Std 1100 IEEE Recommend Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book)
   3. Telcordia:
      a. NEBS 3 as defined for RBOC-CO compliance.
   4. NFPA
      a. NFPA-70 National Electric Code (NEC)

B. Testing Procedures:
   1. NEBS GR-63-CORE: Network Equipment-Building System Requirements: Physical Protection.
   2. NEBS GR-1089-CORE: Electromagnetic Compatibility and Electrical Safety -- Generic Criteria for Network Telecommunications Equipment

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers, Grounding/Earthing Systems:
   1. Panduit
   2. Chatsworth
   3. Harger
   4. Burndy

B. Acceptable Manufacturers, Telecommunications Grounding Busbar:
   1. Panduit
   2. Chatsworth
   3. Harger
   4. Burndy

C. Acceptable Manufacturers, Rack Grounding Kits:
   1. Panduit
   2. Chatsworth
   3. Harger
   4. Burndy

2.2 GROUNDING/EARTHING AND BONDING

A. General:
   1. Conductors: Provide copper grounding/earthing conductors.
   2. Lugs, grounding strips, and busbars: UL Listed. Fabricate with premium quality tin-plated electrolytic copper, providing low electrical resistance while inhibiting corrosion. -Provide antioxidant for field- bonding connections.

3. Lugs: NEBS Level 3. Provide two-hole lugs with irreversible compression and inspection windows, certified for use in non-corrosive environments so that connections may be inspected for full conductor insertion.
4. Die index numbers: Embossed on compression connections to allow crimp inspection.
5. Cable assemblies: UL Listed and CSA Certified.
   a. Cables: Green or green/yellow.
   b. Jackets: UL Listed, VW-1 flame rated.

B. Telecommunications Bonding Backbone (TBB): At cable used to ground/earth TGB; comply with J-STD-607-A guidelines and provide gauge not lighter than the following:

Sizing of the TBB	
TBB Length in Linear meters (feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
Greater than 20 (66)	3/0

C. Grounding Cable, Typical: For applications other than TBB, provide gauge not lighter than the following:

Cable Sizes for Other Grounding/Earthing Applications	
Purpose	Copper Code Cable Size
Aisle grounds (overhead or under floor) of the common bonding network	#2 AWG or larger (1/0 preferred)
Bonding conductor to each PDU or panel board serving the room.	Size per NEC 250.122 & manufacturer recommendations
Bonding conductor to HVAC equipment	6 AWG
Building columns	4 AWG
Cable ladders and trays	6 AWG
Conduit, water pipe, duct	6 AWG

2.3 COMPONENTS, KITS AND HARDWARE

A. Provide BICSI/J-STD-607-A telecommunications grounding busbars for the TMGB. Locate TMGB at AC service entrance.

1. Provide BICSI/J-STD-607-A telecommunications grounding busbars for the TGB at typical telecommunications/equipment spaces throughout the building.
2. Provide compression type two hole lugs for connecting conductors to TMGB and TGB.

PART 3 - EXECUTION

3.1 ROUTING TBB AND TGB

A. Route the TBB to each TGB in as straight a path as possible. The TBB should be installed as a continuous conductor, avoiding splices where possible. When more than one TBB is used, bond them together using the TGBs on the top floor and every third floor in between with a conductor known as a Grounding Equalizer (GE). Use the J-STD-607-A guidelines for sizing of the TBB when sizing the GE (shown in the table above).

B. Avoid routing grounding/earthing conductors in metal conduits. If the grounding/earthing conductor must be routed through a metal conduit, bond each end of the conduit to the grounding/earthing conductor. Use grounding clamps to bond to the conduit and #6 AWG copper conductor to connect the grounding clamp to the GB.

3.2 RACK GROUNDING/EARTHING

A. Bonding Equipment and Racks: Comply with ANSI/TIA-942.

B. To provide electrical continuity between rack elements, use paint piercing grounding washers where rack sections bolt together, on both sides, under the head of the bolt, and between the nut and rack.

C. Utilize full-length rack ground strips attached to the rear of the side rail with thread-forming screws provided to ensure metal-to-metal contact.

D. Mount an electrostatic discharge (ESD) port kit, directly to the rack grounding strip on the back of the rack at approximately 48 inches from the floor. Mount a second electrostatic discharge (ESD) port kit directly to the vertical mounting rail of the rack in the front at approximately the same height. Use the thread-forming screws provided to form a bond to the rack.

E. When the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. Use the appropriate jumper for the equipment being installed and the thread-forming screws provided in the kit.

F. Do not bond racks or cabinets serially.

G. Bond patch panels to racks using bonding screws.

3.3 GROUNDING SYSTEM

A. Communications grounding system: Comply with ANSI/TIA-942 and J-STD-607-A.

B. Connection to Building ground/earth: Ensure connection is made by a licensed, electrical Installer, including installation and termination of the main bonding conductor to the building service entrance ground.

C. Bond TMGB to building steel; ground/earth to electrical service ground specified in Section 27 05 26. Comply with BICSI TDM Manual and J-STD-607-A guidelines.

END OF SECTION 27 05 26

SECTION 270528.36

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Continuous, rigid, welded steel wire mesh cable tray system used in industrial, commercial, and telecommunications applications.

B. Cable tray systems are defined to include, but are not limited to, straight sections, supports and accessories.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Related Sections:
   1. Division 27 00 00 Telecommunications Cabling Systems for voice and data cabling associated with system panels and devices.

B. Bidding Requirements:
   1. Submit complete detailed proposals with line item cost representation for components and associated installation labor. Lump sum bids will not be accepted.
   2. Include as part of the bid response the following items:
      a. Installation schedule with proposed manpower assignments.
      b. Resumes for project manager and lead technician for this project.
   3. Review associated “TA” Series, electrical, audiovisual/telecommunications infrastructure drawings to verify that necessary conduit and floor boxes are coordinated. Understand and coordinate shared infrastructure locations for AV and voice/ data outlets. Any discrepancies with the identified infrastructure to support these systems should be questioned in the form of a request for information (RFI) during the bidding process. Be responsible for any additional infrastructure requirements after receipt of contract for this project. No wiremold or surface mounted raceways shall be approved on this project unless specifically identified elsewhere in the contract daocuments.

1.4 REFERENCES

A. IEC 61537 (2001) – Cable Tray Systems and Cable Ladder Systems for Cable Management

B. NEMA VE 1-2002/CSA C22.2 No. 126.1-02 – Metal Cable Tray Systems

C. ANSI/NFPA 70 (2005) – National Electrical Code (NEC)

D. TIA 569-A (1998) and addendums – Commercial Building Standard for Telecommunications Pathways & Spaces

E. ASTM A 510 - Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

F. ASTM A 380 – Specification for Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

G. ASTM B 633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel

H. ASTM A 123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

I. ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality

J. Norm NF/A 91-131 for Galvanized Steel

K. Norm NF/EN 12-329 for Electrozinc Coating

L. Norm NF/EN/ISO 14-61 for Hot-Dipped Galvanized Steel

M. Norm NF 10-088-2 for Stainless Steel

1.5 SYSTEM DESCRIPTION

A. This section outlines the performance for the noted cable tray support systems, as indicated on the "TA" Series drawings. The tray system shall provide a common raceway for telecommunications cable into and out of the Telecommunications Rooms (TR). Cable tray systems shall also be installed above finished ceiling in the common area hallways that are located on all floors of the building. The common area cable tray is intended to support telecommunications cabling from any of the station cable wall/floor outlet locations on any floor. Each station cable wall/floor outlet shall have a configuration of conduit pipe run to the tray system to support the aforementioned station cabling. It is intended to have this tray system transition (via a Cable Dropout or Runway Radius Drop) into the ladder tray installed above the noted equipment racks to be located in the TR's.

1.6 DESIGN REQUIREMENTS

A. Maximum Deflection between Supports: L/240.

1.7 SUBMITTALS

A. Comply with requirements of Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including UL Classification and NEMA/CSA Certification.

C. Coordination Drawings: Include floor plans and sections drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural and mechanical

elements. Data presented on these drawings are as accurate as preliminary surveys and planning can determine. Field verification of all dimensions, routing, etc., is directed.

D. Informational Submittal: Submit a detailed bill-of-materials listing all part numbers and quantities for this project.

E. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions, and accessories. Show layout, support, and installation details.

F. Manufacturer Qualifications: Submit manufacturer's certification indicating ISO 9001 quality certified.

G. Design Calculations: Verify loading capacities for supports.

H. Submit training procedure for certifying cable tray installers.

I. Submit Factory-certified test reports of specified products, complying with IEC 61537, NEC, and NEMA VE 1/CSA C22.2 No. 126.1.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Manufacturer Qualifications: ISO 9001 quality certified.

C. Comply with NFPA 70. National Electrical Code, Article 392: Cable Trays; provide UL Classification and labels.

D. Provide ETL test documentation showing cable compression/deformation testing.

1.9 COORDINATION

A. Coordinate layout and installation of cable tray with other installations.
   1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.

B. Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage. Protect materials and finishes during handling and installation to prevent damage

C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Cooper Industries B-Line 509 West Monroe St. Highland, IL 62249. Phone: (800) 851-7415. Fax: (800) 356-1438. Website: www.cooperindustries.com. Email: blineus@CooperIndustries.com or approved equal.

2.2 CABLE TRAY SYSTEM

A. Description: Cooper B-Line, Inc. FLEXTRAY continuous, rigid, welded steel wire mesh cable tray system.
   1. Mesh System: Permits continuous ventilation of cables and maximum dissipation of heat.
   2. Safety Edge: Continuous safety edge T-welded wire lip.
   3. Wire Mesh: Welded at all intersections.

B. UL Classification: Straight sections 4 x 8, 12, and 18 inches (108 x 200, 300, and 450 mm), UL classified. Width of tray shall be determined based on not exceeding industry standards for fill ratios.

C. Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.

D. Finish for Carbon Steel Wire: Finish applied after welding and bending of mesh.
   1. Electro-Plated Zinc Galvanizing: ASTM B 633, Type III, SC-1, or
   2. Hot-Dipped Galvanizing: ASTM A 123, or
   3. Black Powder Coat: Powder painted surface treatment using ASA 61 black polyester coating.

E. Nominal Dimensions:
   1. Mesh: 2 x 4 inches (50 x 100 mm).
   2. Straight Section Lengths: 118 inches (3,000 mm).
   3. Width: [12 inches (300 mm)], [18 inches (450 mm)], [24 inches (600 mm)].
   4. Depth: [4 inches (108 mm)].
   5. Wire Diameter: 0.196 inch (5 mm), minimum.

F. Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.

G. Support System: Standard.
   1. Wall Installation: CS Bracket. Maximum tray width of 12 inches (300 mm).
   2. Trapeze Mounting to Ceilings. Maximum tray width of 24 inches (600 mm).
   3. Ceiling Installation: CSC Bracket. Maximum tray width of 12 inches (300 mm).
   4. Fasteners: As required by tray widths. Furnished by manufacturer.

H. Hardware: Hardware, including splice connectors and support components furnished by manufacturer.

2.3 ACCESSORIES

A. Shielding Divider Strips: Divider strips to follow contour of cable tray run for shielding to run multiple signal types in the same tray. Pre-galvanized steel, [4 x 1-1/2 inches (108 x 30 mm)].

B. Fittings: Tees, crosses, risers, elbows and other fittings as indicated, of the same materials and finishes as cable tray.

C. Grounding: GTA-2-2 grounding lugs for attachment on tray of continuous ground conductor fixing system.

2.4 FIRE STOP CABLE PASS-THRU SLEEVES

A. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Exam areas to receive cable management system. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install cable tray level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

B. Install cable management system at locations indicated on the drawings and in accordance with manufacturer's instructions. Provide firestopping at penetration into/ out of Telecommunication rooms.

C. Load Span Criteria: Install and support cable management system in accordance with span load criteria of L/240.

D. Cutting:
   a. Cut cable tray wires in accordance with manufacturer’s instructions.
   b. Cable tray wires must be cut with side-action bolt cutters with offset head to ensure integrity of protective galvanic layer.
   c. Remove burrs and sharp edges from cable trays.

E. Install cable management system using hardware, splice connectors, support components, and accessories furnished by manufacturer.

F. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed 90 feet.

G. Ground cable tray according to manufacturer’s written instructions.

H. The cable tray and ceiling installation shall allow for re-entry to accommodate additional cable to be pulled from all occupied spaces to their respective IDF locations on each floor.

I. Certified Installers: Cable tray installers must have successfully completed Manufacturer’s Certified Installer program.

3.3 FIRESTOPPING CABLE TRAY ENTRANCE

A. Firestopping In Telecommunications Room At Cable Tray Entrance
   1. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Firestopping where cable tray passes through a rated wall assembly.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping."

C. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.

D. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

END OF SECTION 27 05 28.36

SECTION 27 05 28.45

TELECOMMUNICATIONS FLUSH POKE-THRU DEVICE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Telecommunications cabling poke-thru.

B. Related Sections include the following:
   1. Division 09 Sections for Floor Coverings.
   2. Division 26 Electrical Section.
   3. Division 27 Telecommunications Systems.

1.2 PERFORMANCE REQUIREMENTS

A. General: These poke-thru devices provide the interface between power, communication and audio/ visual (A/V) cabling in an above grade concrete floor and the workstation or activation location where power communication and/or A/V device outlets are required. These poke-thru devices provide recessed device outlets that will not obstruct the floor area.
   1. ADA Compliance: Flush-mounted floor device outlets shall not create tripping hazard.

B. Floor Mounted Connector Assembly: These poke-thru devices provide flush device outlets that will not obstruct the floor area.

C. Labeling: Floor boxes shall bear the “cULus mark” issued by UL for units complying with both US and Canadian Standards.

D. Classification and use.
   1. This poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to Standard UL514A and/or UL514C and Canadian Standard C22.2, No. 18-98 and bear the U.S. and Canadian UL Listing Mark. This poke-thru device shall also have been tested by Underwriters Laboratories Inc. and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. Devices shall be classified for use in 1-, 1 1/2-, or 2-hour rated, unprotected reinforced concrete floors and 1-, 1 1/2-, or 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series Designs) or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the poke-thru fittings. This device shall also conform to the standards set in the National Electric Code, Section 300-21. These devices meet all UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens. This poke-thru device shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors. Suitable for use in air handling spaces in accordance with Sec 300-22 (C) of the National Electrical Code.
   2. Standards: Comply with the following:
   3. UL514A and/or UL514C and Canadian Standard C22.2, No. 18-98 and bear the U.S. and Canadian UL Listing Mark

4. National Electrical Code.

1.3 SUBMITTALS

A. Comply with requirements of Section 01 33 00 - Submittal Procedures.

B. Submittal data is to be submitted in a three ring binder, a continuous spiral binder, or plastic binding that allows the booklet to lie flat while open. Each booklet shall contain the below in the following order:
   1. Cover Sheet.
      a. Include name of supplying contractor and project name.
   2. Product Data.
      a. Include a catalog sheet per product. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include a image of the product. Photocopy duplications of the manufacturer's original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures. If more than one product is shown on the catalog sheet the intended product must be denoted by either an arrow or highlight.
   3. Informational Submittals.
      a. Manufacturer's installation instructions.

C. Shop Drawings are to be submitted on project standard full size and bound. Each shop drawing set is to include the below in the following order:
   1. Floor plans showing poke-thru locations based on column grid lines.

PART 2 - PRODUCTS

2.1 POKE THRU DEVICE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are limited to, the following:
   1. Wiremold, Legrand
   2. Hubbell Premise Wiring.
   3. Approved equal.

B. The same manufacturer shall provide all poke-thru types for the project.

2.2 MATERIALS 6AT POKE-THRU ASSEMBLY.
   1. This assembly consists of an insert and an activation cover. Overall poke-thru assembly length shall be 16 3/4" [425mm].

B. Insert
   1. The insert body shall recess the devices a minimum of 2 3/4" [69 mm] and have a polyester based backing enamel finished interior (ivory). There shall be the necessary channels to provide complete separation of power and communication services. There shall be three compartments two side compartment for duplex receptacles that can be wired as a standard receptacle or isolated ground and on center compartment that can accommodate up to eight communication ports.

2. The body will consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire rating of the unit and the floor slab. The insert shall have retaining feature that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 3/4" trade size conduit stub that is connected to the insert body and a 24.5 cu. in. [402ml] stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru device to the system ground.

C. Activation Cover:
1. The activation covers shall be manufactured of die-cast aluminum alloy and be available in powder-coated gray, black, or plated in brass, nickel or bronze finish. Two gaskets (one for carpet and one for tile) are provided to go under the trim flange to maintain scrub water tightness. The activation cover shall be 7 1/4" [184mm] in diameter. The activation covers shall be available in carpet and tile versions. The carpet covers shall be surface mounted and the tile covers shall be flush with the finished floor covering. The cover shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.

D. Communication Modules Mounting Accessories:
1. The activation shall have one location to mount communication connectors. Connectors shall be mounted using a mounting bracket. Mounting brackets shall be provided to mount up to eight Ortronics TracJack Category 6 insert modules or Category 3. 5e. or 6 keystone connectors. The unit shall also accommodate a mechanism to permit protection of communication cabling. This mechanism shall be stamped steel construction and accept both flexible and rigid conduit. This mechanism shall accept 3/4", 1-1/4" or 2" trade size conduits.

E. Provide pull strings in each conduit at poke thru location.

F. The floor box manufacturer shall have available a complete line of workstation connectivity outlets and modular inserts, and Connectivity Modular Inserts for UTP, Fiber Optic, Coaxial, and other cabling types with faceplates and bezels to facilitate mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. With Installer present, verify that manufacturer’s requirements for floor opening and infrastructure conditions have been satisfactorily met. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Arrange for jobsite approval of the equipment prior to commencing installation.

B. Verify exact locations of poke-thru installation.

3.3 INSTALLATION

A. Install equipment in compliance with approved shop drawings and manufacturer's installation instructions.

B. Unit shall permit all wiring to be completed at floor level. The 6AT unit shall mount in a 6" [152mm] cored hole, actual 6 1/16" [154mm] core hole.

C. Use is defined by the UL Fire Resistance Directory as a minimum spacing of "2 ft. [610mm] on center and not more than one device per each 65 sq. ft. [6m2] of floor area in each span."

D. Installation shall be completed by pushing unit down into the cored hole. Prior to and during installation, refer to system layout and/or approval drawings. Installer shall comply with detailed manufacturer's instruction sheet included with each device. The unit shall contain a retainer for securing the device in the slab, as well as the necessary intumescent material to seal the cored hole under fire conditions.

E. The trim flange color and texture is to be coordinated with architect.

3.4 COPPER CROSS SECTIONAL AREA

A. The maximum copper cross sectional area for the 6AT outer compartment only is .0154 sq. in. [9.9 mm2]. The maximum copper cross sectional area for the center compartment only is .0387 sq. in. [24.9mm2].

3.5 ADJUSTING

A. Adjust poke-thru for proper operation.

3.6 PROTECTION

A. Protect installed equipment in original undamaged condition until Substantial Completion. Remove and provide new components or units that cannot be repaired to the satisfaction of the Architect.

END OF SECTION 27 05 28.45

SECTION 270528.49

TELECOMMUNICATIONS CABLING SYSTEMS FLOORBOX

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Telecommunications Cabling Floorbox.

B. Related Sections include the following:
   1. Division 9 Sections for Floor Coverings.
   2. Division 27 Electrical Section Telecommunications Systems, Audiovisual Systems, wiring, connections, and installation of associated conduit infrastructure.

1.2 PERFORMANCE REQUIREMENTS

A. General: Floor boxes provide interface between power and telecommunication cabling in concrete floors and decks at workstations or at activation locations requiring power or communication device outlets.
   1. ADA Compliance: Flush-mounted floor device outlets shall not create tripping hazard.

B. Floor Mounted Connector Assembly: Watertight, rubber cable pass thru gasketed door and cover assembly, utilizing basket and connector mounting panel inserts.

C. Labeling: Floor boxes shall bear the “cULus mark” issued by UL for units complying with both US and Canadian Standards.

D. Standards: Comply with the following:
   1. UL 514A and Canadian Standard C22.2.
   2. National Electrical Code.

1.3 SUBMITTALS

A. Comply with Section 013300 Section *Submittal Procedures*.
   1. Product Data: Floor boxes, trim, and accessories.
   2. Shop Drawings: For conduit terminations/ cable types.
      a. Include a detailed riser drawing indicating conduit runs and associated (box knockout) cables within.
      b. Provide floor plans showing floorbox locations based on column grid lines.
   3. Informational Submittals:
      a. Manufacturer’s installation instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Telecommunications Cabling Floorbox:
   1. Basis for Design: Resource Series RFB-4, Wiremold
   2. Other acceptable manufacturers:
      a. FSR (800) 332-3771
      b. Mystery Electronics (800) 798-2256
      c. Ace Backstage (661) 295-5760

2.2 MATERIALS

A. Door and Cover: Not lighter than 11 gauge steel with integral, self trimming carpet trim ring. Mount trim ring flush with floor covering. Secure with security socket head screws.
   1. Finish: Satin black coating.
   2. Trim: Door, cover, and integral trim ring shall have radiused corners.

B. Boxes: One or two-gang configurations.
   1. Shape: Rectangular.
   2. Adjustability: Able to adjust units before and after concrete placement.
   3. Modular Design: Provide removable barrier between individual compartments to enable increased capacity after installation.
   4. Materials:
      a. Elevated Decks: Stamped-steel.
      b. Slab-on-grade: Cast-iron.

C. Box interior and exterior shall be painted. Boxes shall be available in one and two-gang configurations. All cast-iron versions shall provide 1 3/4" (44mm) of pre-pour adjustment and 1/2" (12.7mm) of post-pour adjustment. Minimum depth of boxes shall be 3 7/16" (87mm).

D. Each box shall contain four locations to accommodate leveling for pre-concrete pour adjustment. Each box shall provide four leveling screws for this pre-pour adjustment.

E. Overall box dimensions shall be as follows:
   1. Four-gang: 8-3/16 inches (132mm) wide by 8 - ½ inch (216mm) long.

F. Provide at least 48 cubic inches (787ml) of Device Wiring Chamber volume.
   1. Provide at least four 1¼” (45mm) threaded conduit openings to feed cabling to the floor box.

G. Provide pull strings in each conduit at floor box location. Coordinate conduit to box knockout location with telecommunication cabling and audiovisual systems requirements. Terminate a duplex power receptacle, up to eight (8) CAT. 6 type data outlets, along with a waterproof cable pass-through.

H. The floor box manufacturer shall have available a complete line of workstation connectivity outlets and modular inserts, and Activate Connectivity Modular Inserts for UTP (including Cat 6), Fiber Optic, Coaxial, and other cabling types with faceplates and bezels to facilitate mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The minimum concrete pour depth shall 3-1/2 inches (89mm).

B. With Installer present, verify that manufacturer's requirements for floor opening and infrastructure conditions have been satisfactorily met. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Arrange for jobsite approval of the equipment prior to commencing installation.

B. Verify exact locations of floorbox installation.

3.3 INSTALLATION

A. Install equipment in compliance with approved shop drawings and manufacturer's installation instructions.

B. Install in position and relationship to adjoining work indicated, securely anchored to supporting structure, sealed and finished, and in a manner, which produces a level box with square, plumb, and straight edges.

C. Telecommunications Cabling Floorbox shall have a total of two separate EC with pull string at each box as follows:
   1. One (1) 3/4-inch EC from box to circuit panel. (Duplex AC Power)
   2. Two (2) 1-1/4 inch ECs from box to telecomm cable tray A.F.C (CAT. 6 data cables)

D. Coordinate installation with floor covering to finish each floor box. Install floor covering with oversized cable management pop-up pass-thru in top, matching surrounding floor covering in cover insert.

3.4 ADJUSTING

A. Adjust door and cover for proper operation.

3.5 PROTECTION

A. Protect installed equipment in original undamaged condition until Substantial Completion. Remove and provide new components or units that cannot be repaired to the satisfaction of the Architect.

END OF SECTION 27 05 28.49

SECTION 270800 TELECOMMUNICATION SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment Start-Up and Functional Performance Testing.

B. Validation of proper and thorough installation of Division 27 systems and equipment.

C. Generic Start-Up Documentation for electrical systems and equipment.

D. Development of final testing documentation for telecommunication systems and equipment.

E. System Turn-Over procedures.

F. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

A. Commissioning (Commissioning) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section outlines the Cx procedures specific to the Division 27 Contractors. Requirements common to all Sections are specified in Sections n 019113 and 019114 This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

1.3 SCOPE

A. The following systems and equipment are included in the Scope of Commissioning for this project:

1. Inside cable plant
2. Outside cable plant

1.4 RELATED WORK AND DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. The Cx process references many related Sections, particularly Section 019113 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 019113.

C. Refer to Section 019113 for a complete list of Sections on Related Work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

A. Local Building Codes

B. National Fire Protection Association (NFPA)

C. National Electric Code (NEC)

D. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

E. Institute of Electrical and Electronics Engineers (IEEE)

F. Underwriters Laboratory, Inc. (UL)

G. Refer to Section 019113 for additional Reference Standards.

1.7 DOCUMENTATION

A. Documentation shall be as required in Section n 019113. In addition, Contractor shall also provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports shall be provided in PDF electronic format.
2. Field Testing Agency Reports: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format.

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 27.

B. Construction Phase

1. Coordinate checkout of the fire alarm system and the approval of the regulatory authorities with the Cx process.

1.9 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. Unless otherwise noted, all equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Testing Instrumentation: Contractor shall provide all instrumentation necessary for tests for which they are responsible. CA will provide standard instrumentation for measuring medium and low voltage electrical voltage, current. CA will provide receptacle testers for normal and GFI receptacle tests. Contractor shall provide all other instrumentation required to accomplish the specified testing.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

2.3 ACCESS DEVICES

A. Contractor shall provide all access devices necessary to support functional testing.

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines 'generic' or minimally acceptable Start-Up Documentation (which are defined to include both 'Start-Up Checks' and 'Start-Up Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 019113 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.

3.2 START-UP CHECKS COMMON TO ALL SYSTEMS

A. The following Start-Up verifications and procedures shall be considered common to all systems:

1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
2. Verify labeling is affixed per specification and visible.
3. Verify prerequisite procedures are done.
4. Inspect for damage and ensure none is present.
5. Verify system is installed per the manufacturer's recommendations.
6. Verify system has undergone Start-Up per the manufacturer's recommendations.
7. Verify that access is provided for inspection, operation and repair.
8. Verify that access is provided for eventual replacement of the equipment.
9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
10. Verify all recorded nameplate data is accurate.
11. Verify that the installation ensures safe operation and maintenance.
12. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.

3.3 RISER/HORIZONTAL CABLE

A. General: Provide the services of a certified specialist to supervise the installation, make adjustments, and perform tests on the Cabling system and train Owner's maintenance personnel.

B. Perform the following tests as applicable to the cable type

1. Ensure all labeling is affixed and accurate
2. Ensure all terminations are tight.
3. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
4. Review that all field input and output devices as shown on the construction drawings and shop drawings are installed.
5. Visual inspection of all wiring.
6. Category 6 cables: Test all circuits between the telephone board/patch panels and the stations for wire map; insertion loss; length; NEXT loss, pair to pair, measured from measured from local end; NEXT loss, power sum, measured from far end; NEXT loss, power sum, measured from far end; ELFEXT, pair-to-pair; ELFEXT, power sum; return loss, measured from local end; return loss, measured from far end; propagation delay; and delay skew. Voice cables do not have to meet the TIA/EIA 568 Category 6 standards.
7. Telephone Exterior and Riser Cables: Test all circuits between the terminal boards for opens, shorts, grounds, and impedance to ensure integrity of the telephone cable
8. Fiber Optic Cable: Each fiber shall be tested for power through loss to reflect the end to end loss including connectors. End-to-end loss shall be measured from bulkhead-to-bulkhead to include splice jumper and connector losses. Fiber loss measurements shall be made in conformance with the fiber optic TIA/EIA standards and with the fiber manufacturer's recommendations. Measurements shall be recorded on a per strand basis with loss measured for each strand.

END OF SECTION 270800

SECTION 274113

MULTIMEDIA SYSTEMS FLOORBOX

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Multimedia Systems Floorbox.
   2. ITV Floorbox

B. Related Sections include the following:
   1. Division 9 Section *Floor Coverings*.
   2. Division 26 Electrical Sections for audiovisual systems, telecommunications systems, wiring, connections, and associated conduit infrastructure.

1.2 PERFORMANCE REQUIREMENTS

A. General: Floor boxes provide interface between power, audiovisual, and telecommunications cabling in concrete floors and decks at workstations or at activation locations requiring power, audiovisual, or communication device outlets.
   1. ADA Compliance: Flush-mounted floor device outlets shall not create tripping hazard.

B. Floor Mounted Connector Assembly: Watertight, rubber cable pass thru gasketed door and cover assembly, utilizing basket and connector mounting panel inserts.

C. Labeling: Floor boxes shall bear the “cULus mark” issued by UL for units complying with both US and Canadian Standards.

D. Standards: Comply with the following:
   1. UL 514A.
   2. National Electrical Code.

1.3 SUBMITTALS

A. Comply with Division 1 Section *Submittal Procedures*:
   1. Product Data: Floor boxes, trim, and accessories.
   2. Shop Drawings: For conduit terminations/ cable types.
      a. Include detailed riser drawings; show conduit runs and associated box knockout cables within.
      b. Provide floor plans showing floorbox locations based on column grid lines.
      c. Provide build quality drawings for approval of custom floorbox design prior to fabrication.
   3. Informational Submittals:
      a. Submit Manufacturer’s installation instructions.
   4. Photos:
      a. Submit a photo of each placed floorbox with associated conduit prior to slab pour.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Legrand/Wiremold or approved equal.

B. Multimedia Systems Floorbox:
   1. EFB8S

C. ITV Floorbox:
   1. CCBBL with custom 16" depth
   2. Quote number 0952-002-APP

2.2 MATERIALS

A. Multimedia Systems Floorbox
   1. Door and Cover: Not lighter than 11 gauge steel with integral, self trimming carpet trim ring. Mount trim ring flush with floor covering. Secure with security socket head screws.
      a. Finish: Satin black coating.
      b. Trim: Door, cover, and integral trim ring shall have radiused corners.
   2. Device Plates
      a. Provide device plates as detailed on drawings.
      b. Provide blank plates as necessary
   3. Boxes:
      a. 11 gauge steel, 15 13/16 inches by 12 3/4 inches by 6 1/16 inches deep.
      b. Mount on manufacturer's backbox.

B. ITV Floorbox
   1. Door and Cover: Cast aluminum cover assembly with carpet trim ring. Mount trim ring flush with floor covering. Secure with security socket head screws.
      a. Finish: Peened textured.
      b. Trim: Door, cover, and integral trim ring shall have radiused corners.
   2. Device Plates
      a. Provide device plates as detailed on drawings.
      b. Provide blank plates as necessary
   3. Boxes:
      a. 0.71" thick stamped steel, 15 1/4 inches by 15 1/4 inches by 16 inches deep.
      b. Mount on manufacturer's backbox.

C. Provide pull strings in each conduit at floor box location. Coordinate conduit to box knockout location with telecommunication cabling and audiovisual systems requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The minimum concrete pour depth shall be 6 inches (less decking). If less than 6 inches provide fire stopping around box as needed.

B. With Installer present, verify that manufacturer's requirements for floor opening and infrastructure conditions have been satisfactorily met. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Arrange for jobsite approval of the equipment prior to commencing installation.

B. Verify exact locations of floorbox installation.

3.3 INSTALLATION

A. Install equipment in compliance with approved shop drawings and manufacturer's installation instructions.

B. Install in position and relationship to adjoining work indicated, securely anchored to supporting structure, sealed and finished, and in a manner, which produces a level box with square, plumb, and straight edges.

C. Multimedia Systems Floorbox shall have a total of four (4) separate Electrical Conduit (EC) with pull-string at each box as follows:
   1. One (1) 3/4-inch EC from box to circuit panel. (Duplex AC Power)
   2. One (1) 1-1/4 inch from box to accessible A.F.C.
   3. Two (2) 1-1/2 inch from box to within 4" of projector location.

D. Coordinate installation with floor covering to finish each floor box. Install floor covering with oversized cable management pop-up pass-thru in top, matching surrounding floor covering in cover insert.

E. Provide blank plates for any unused positions within floorbox.

3.4 ADJUSTING

A. Adjust door/cover for proper operation.

3.5 PROTECTION

A. Protect installed equipment in original undamaged condition until Substantial Completion. Replace damaged components for units that cannot be repaired prior to Substantial Completion.

END OF SECTION 27 41 13

SECTION 275100 – DISTRIBUTED AUDIO-VISUAL COMMUNICATION, SECURITY SUPPLEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to 280500 Part 1

1.2 DESCRIPTION OF WORK

A. Refer to 280500 Part 1

1.3 RELATED DIVISION PROVISIONS

A. Refer to 280500 Part 1

1.4 REFERENCES

A. Refer to 280500 Part 1

1.5 SUMMARY

A. Section includes requirement of Division 28 security contractor to support electronic security systems work. This section provides requirements for planning, supplementary submittal requirements, product specifications and installation of conduit and electrical power systems supporting electronic security.

1.6 DEFINITIONS

A. Refer to 280500 Part 1

1.7 SUBMITTALS

A. Refer to 280500 Part 1

1.8 COORDINATION

A. Refer to 280500 Part 1

1.9 QUALITY ASSURANCE

A. Refer to 280500 Part 1

1.10 MAINTENANCE & SERVICE

A. Refer to 280500 Part 1

1.11 SYSTEM DESCRIPTION

A. The system shall be coordinate with 280500.

1.12 PERFORMANCE REQUIREMENTS

A. Refer to 280500 Part 1

1.13 DELIVERY HANDLING & STORAGE

A. Refer to 280500 Part 1

1.14 PROJECT CONDITIONS

A. Refer to 280500 Part 1

1.15 EQUIPMENT AND MATERIALS

A. Refer to 280500 Part 1

1.16 ELECTRICAL POWER

A. Refer to 280500 Part 1

1.17 ENVIRONMENTAL CONDITIONS

A. Refer to 280500 Part 1

1.18 LIGHTNING, POWER SURGES, & GROUNDING

A. Refer to 280500 Part 1

1.19 COMPONENT ENCLOSURES

A. Refer to 280500 Part 1

1.20 ELECTRONIC COMPONENTS

A. Refer to 280500 Part 1

1.21 SUBSTITUTE MATERIALS & EQUIPMENT

A. Refer to 280500 Part 1

1.22 LIKE ITEMS

A. Refer to 280500 Part 1

1.23 WARRANTY

A. Refer to 280500 Part 1

1.24 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

A. Refer to 280500 Part 1 and Part 2

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ramtel – No Exceptions

2.2 EXISTING SYSTEMS

A. The emergency call box units provided under the scope of this project shall be completely integrated with the existing systems.

2.3 EMERGENCY CALL BOX

A. General

B. The Emergency Call Box shall consist of an outdoor-rated, vandal resistant and ADA-compliant hands-free speakerphone communications device with a stainless steel faceplate and metal buttons. The Emergency Call Box shall one red anodized aluminum tactile button labeled "EMERGENCY" and one 0.375" diameter red light emitting diode (LED) labeled "LIGHT ON INDICATES CALL RECEIVED". The unit shall be programmable from a remote location and have a two number dialing capability, reverting to the second number if the first is busy or does not respond. The unit shall be totally hands-free on both sides after connection is initiated at site or by attendant. The unit shall be phone line powered, requiring no outside power source or battery back-up. DIP switch programming, push to talk devices, and devices requiring external power are not acceptable. The unit shall have a dedicated communication line.

C. Construction

1. Chassis, back box and face plate shall be constructed of stainless steel.

2. Faceplate shall be 12 gauge #4 brushed stainless steel measuring 9.5" W x 11.75" H.

3. Unit shall weigh approximately 8 lbs.

4. Signage shall be constructed of cast metal with lettering and Braille raised approximately 3/32" for ADA compliance.

5. Word "EMERGENCY" and button shall be red.

6. Push button and switch shall be a single assembly rated for 1,000,000 cycles.

7. Speaker and microphone shall be protected by non-ferrous metal screen to provide a barrier against vandalism, rain and snow.

D. Features

1. Unit shall be capable of operating on standard phone lines or analog PBX extensions.

2. Unit shall dial at approximately 10 tones per second.

3. Output sound level shall be greater than 80 dB at one meter for normal conversation.

4. All programming shall be stored in non-volatile EEPROM memory.

5. Button shall provide tactile feedback.

6. Unit shall be programmable from a remote telephone via keypad entry.

7. Call timer shall be programmable from 1 to 4320 minutes.

8. LED for the hearing impaired shall illuminate to indicate when calling party may speak (when receiving party is silent).

9. Unit shall be programmable with two different telephone numbers of up to 18 digits each including pauses. If first number does not answer or is busy, unit shall automatically call the second number. If that number is busy or does not answer, unit shall call the first number again. Unit shall continue alternating until call is answered or call timer limit is reached.

10. Unit shall include two auxiliary outputs and one auxiliary input that are opto-isolated from the telephone line to 1,000 volts. Outputs shall be activated, providing a dry contact closure, either automatically when Emergency Phone is activated or manually by guard keypad operation. Input shall allow unit to be activated by any device or switch that provides a contact closure.

11. Incoming and outgoing volume shall be adjustable separately.

12. Unit shall be capable of automatically notifying attendant of location via programmable 6 digit ID.

13. Unit shall be capable of silent monitoring.

14. Unit shall utilize tone dialing.

15. When call is finished, unit shall automatically shut off.

16. Unit shall answer any call placed to it from any other telephone.

17. Two levels of programmable passwords shall be available.

18. Unit shall be varistor lightening suppressed and full wave polarity guarded.

19. Unit shall have parallel tip and ring connected to an RJ-11 connector for quick installation.

20. Unit shall be compatible with RAMTEL's All Campus Alert System.

21. Unit shall comply with Part 68 of the FCC rules for the United States.

E. Environmental

1. Speaker: Unit shall have a 3.5 inch waterproof speaker with a vinyl-impregnated cloth cone. Magnet and solid aluminum voice coil area shall be protected from ferrous and non-ferrous particles by a special sealed design. The speaker shall be capable of operating without deterioration of sound quality after total immersion in water for 96 hours. Speaker shall operate at temperatures of -55ºC to +85ºC. Steel basket shall have a zinc dichromate finish for protection against corrosion.

2. Microphone: Unit shall include a gold, water-resistant microphone.

3. Push Button/Switch: Button and switch shall be a single assembly. Epoxy seals shall protect contacts and terminals from hostile environments and solder flux. Unit shall be waterproof and submergible to 3 feet in water. Unit shall have a mechanical life of 1,000,000 cycles. Case shall be moisture-proof, dust-tight and designed to accommodate the high shock military specifications of MIL-STD-202, method 207. Case shall be aluminum alloy, anodized clear. Button shall be red anodized aluminum. Switch shall be rated to operate from -55ºC to +80ºC.

4. PC boards and Other Electronic Components: Boards and components shall withstand a corrosive atmosphere of 90% H2S for 16 hours. PC boards shall be rated R4. Unit shall be designed to operate at temperatures from -20ºC to +65ºC and humidity levels up to 95% relative humidity at 49ºC.

5. Protective Sealing of Completed PC Boards: Once the unit has been wave soldered and inspected and the completed boards tested, the entire circuit board apparatus shall be uniformally coated by dipping rather than spraying (Mil-I416058C amend 6). The microprocessor chip shall then be installed in its socket and sealed in place with a special electrical grade RTV type sealant. At this point the boards can be sprayed with water without affecting the operation of the unit.

F. Electrical

1. Unit shall be fully phone line powered, requiring no external power or battery back-up.

2. One dedicated, twisted-shielded communication pair shall provide a minimum of 24VDC and 20mA while off hook.

G. Model

1. The emergency call box shall be a Ramtel model RR-733

H. Options

1. Contractor shall provide custom silk screening of the Owner's logo and the words "Montgomery College" on each emergency call box faceplate.

2.4 WALKWAY LED

A. Provide walkway LED illumination for indoor wall mounted call boxes with technical features as follows:

1. Electrical:

a. 1W LED powered by 120V primary, 3W 350mA non-dimmable integral driver.
b. Input Current: 350mA
c. Input Voltage: 4V DC
d. Power Consumption: 1W

2. Dimming: Dimmable with remote driver (not included). Consult factory.

3. Weight: 0.99lbs (0.45kg).

4. Material: 303 stainless steel and polycarbonate lens.

5. Mounting: Mounts to standard 4” (102mm) octagonal box (1-1/2” (38mm) deep minimum) with flush mounted tamper proof screws.

6. Approval: Dry locations. Approved to UL standards by CSA/US.

B. Manufactured unit shall be MP Lighting L21 Walkway LED or approved equal.

C. Contractor shall provide a resistor in-line with the Walkway LED to reduce the voltage from the 12 VDC power supply to a useable level.

2.5 EMERGENCY CALL BOX TOWER MOUNT

A. Illumination

1. The tower mount has three (3) different lights.

2. Sodium Vapor Blue Light - A high intensity 50 watt light illuminates immediate area around the tower. The blue light is continuously lit.

3. Strobe Light - A one million candle power strobe housed in a blue Fresnel Lexan polycarbonate lens is provided. The strobe flashes continuously when the emergency call button is pushed and shuts off when the calling party hangs up.

4. Phone Panel Light - A five (5) watt fluorescent light illuminates the emergency call box face plate.

B. Construction

1. 0.25" thick non-rusting, non-magnetic stainless steel

2. Dimensions - 9' x 11" sq.

3. Weight - 175 lbs.

4. Mounting - Four (4) 5/8" x 16" J-Bolts cast into a concrete footer.

5. Color - Coordinate with Owner

6. Finish - Powder Coat

7. Graphics - "EMERGENCY" on all four sides

8. Graphics Color - Coordinate with Owner

9. Power - 120 VAC

C. Model

1. The emergency call box tower mount shall be a Ramtel model PLC-8

D. Options

1. Contractor shall provide the optional internal heating unit

2. Contractor shall provide top-mount camera arm. Installed by Owner.

PART 3 - EXECUTION

3.1 INTERCOMMUNICATION SYSTEMS

A. Installation:

1. The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2 and as shown, and shall furnish all necessary connectors, terminators,

interconnections, services, and adjustments required for a complete and operable emergency communications system.

B. Tamper Resistant Substations:

1. The Contractor shall locate emergency call boxes where shown on the drawings. Provide tamper resistant center post torx screws for mounting the emergency call box units to the tower mounts.

PART 4 - SYSTEM PROGRAMMING

4.1 NOT APPLICABLE

PART 5 - TESTING AND ACCEPTANCE

5.1 REFER TO 280500 PART 5

END OF SECTION 275100

SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The electronic security system (ESS) shall be provided and installed in accordance with the drawings, specifications, and referenced publications.

B. The Contractor shall perform all work, provide products, systems integration, engineering, and design work required for the project in order to ensure complete and fully operational systems and proper installation of equipment. The Contractor shall provide calculations and analysis to support design and engineering decisions as specified in submittals. The Contractor shall provide and pay all labor, materials, and equipment, sales and gross receipts and other taxes. The Contractor shall secure and pay for plan check fees, permits, other fees, and licenses necessary for the execution of work as applicable for the project. Give required notices; the Contractor will comply with codes, ordinances, regulations, and other legal requirements of public authorities, which bear on the performance of work.

C. The Contractor shall provide an ESS, installed, programmed, configured, documented, and tested. The security system shall include but not limited to: access control, video surveillance and assessment, video recording and storage, and intercommunication system. The Contractor shall integrate new ESS, video surveillance, and intercommunications equipment into the Owner's existing systems. End-User training shall be provided as part of the Security Contractors scope. End-User training shall include familiarization, basic system operations and credential production. The Security Contractor shall provide necessary maintenance and trouble shooting manuals as well as submittals as identified herein. The work shall include the procurement and installation of electrical wire and cables, the installation and testing of all system components. Inspection, testing, demonstration, and acceptance of equipment, software, materials, installation, documentation, and workmanship, shall be as specified herein. The Contractor shall provide all associated installation support, including the provision of primary electrical input power circuits.

D. Repair Service Replacement Parts On-site service during the warranty period shall be provided as specified under "Emergency Service". The Contractor shall guarantee all parts and labor for a term of one (1) year, unless dictated otherwise in this specification from the acceptance date of the system as described in Part 5 of this Specification. The Contractor shall be responsible for all equipment, software, shipping, transportation charges, and expenses associated with the service of the system for one (1) year. The Contractor shall provide 24-hour telephone support for the software program at no additional charge to the owner. Software support shall include all software updates that occur during the warranty period.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Requirements of Section 5, Acceptance Testing shall take precedence over Division 01 System Acceptance requirements.

B. Safety Systems: This Division shall apply to Common Work Results for "Electronic Security" only. When applicable, Common Work Results for "Safety" shall precede this division.

C. Security Management System: This Division (280500 - Electronic Security) shall be used as a base document for electronic security systems. The following sections shall be used in conjunction to provide a complete and fully integrated security management system.

1. 280513 – Conductors and Cabling for Electronic Security

2. 281300 – Access Control

3. 282300 – Video Surveillance

4. Supplements: The following supplements shall be considered a part of the above referenced Divisions:

a. 260500.01 – Common Work Results for Electrical – Electronic Security Supplement
b. 275100 – Distributed Audio-Video Communications Systems – Area of Rescue Systems

D. Related Sections include the following:

1. Division 01 Section "General Requirements"

2. Division 08 Section "Door Hardware"

3. Division 26 Supplement "Electrical Work for Electronic Security"

1.3 RELATED DIVISION PROVISIONS

A. Division 1 Provisions: Comply with all applicable requirements including bonding, submittals, testing, and site safety.

B. Division 8 Provisions: The division 8 Contractor at locations shown on the drawings shall provide all door hardware as shown in the door schedule. Door schedule shall detail all necessary components to interface with the security management system. The Security Contractor shall provide all connections between power supplies and the locking equipment.

C. Division 26 Provisions:

1. Dedicated Electrical Power (120 VAC) circuits shall be provided by the contractor as required to provide full system functionality. Dedicated electrical power circuits shall be derived from sources provided with emergency back up power. All data transmission and communications devices shall be on uninterrupted power supplies that provide continuous power for a minimum of (8) eight hours. The Contractor shall provide, terminate, and test all system connections.

2. Contractor shall provide conduit and raceways required by the security systems. Security conduits shall be labeled with blue marking band or blue paint every 30'. Security junction box covers shall be painted with paint manufactured by Benjamin Moore #791, Duron 5085A (Americana) or approved equal.

1.4 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic design only. We intend all publications to be the most current editions but where otherwise noted.

1. American National Standards Institute (ANSI)

   a. ANSI C2 (1990; TIA 90-2; Errata); National Electrical Safety Code
   b. ANSI C39.1 (1981; R 1992); Requirements for Electrical Analog Indicating Instruments
   c. ANSI C42.100 (2000); Standard Dictionary of Electrical and Electronics Terms
   d. ANSI INCITS 154 (1988; R 1999); Office Machines and Supplies - Alphanumeric Machines-Keyboard Arrangement
   e. ANSI INCITS 92 (1980; R 2003); Data Encryption Algorithm
   f. ANSI X3.154 (1988); office machine and supply alphanumeric machine keyboard arrangement.
   g. ANSI X3.64 (1990); Additional Controls for Use by American National Standard Code for ANSI C2(1993); National Electrical Safety Code Information Exchange
   h. ANSI X3.92 (1988); Data Encryption Standard
   i. Alphanumeric Machines/Keyboard Arrangement
   j. ANSI X9.52 (1998); Triple Data Encryption Alogarithm Modes of Operation
   k. ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard (October l995 or newer).
   l. ANS1/TIA/EIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces (October 1990 or newer).
   m. ANSI/EIA/TIA-570 Residential and Light Commercial Telecommunications Wiring Standard (June 199l or newer).

n. ANSI/TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings (February 1993 or newer).
o. ANSI-J-STD-607-A (2002); Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
p. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications (August 1994 or newer).

2. ASTM International (ASTM)

a. ASTM A 123/A 123M (2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
b. ASTM B 3 (2001) Standard Specification for Soft or Annealed Copper Wire
c. ASTM B 32 (2004) Solder Metal
d. ASTM C 1107 (2007) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
e. ASTM D 709 (2001) Laminated Thermosetting Materials
f. ASTM E 84 (2007) Standard Test Method for Surface Burning Characteristics of Building Materials

3. Consumer Electronics Association (CEA)

a. CEA 170 (1957); Electrical Performance Standards - Monochrome Television Studio Facilities
b. CEA-310-E (2005); Racks, Panels, and Associated Equipment
c. CEA-330 (2004); Electrical Performance Standards for Closed Circuit Television Camera 525/60
d. CEA-375-A (2004); Direct View Monochrome Closed Circuit Television Monitors 525/60 Interlaced 2:1

4. Electronic Industries Association (EIA)

a. EIA 170 (1957); Electrical Performance Standards
b. EIA 232-E (1991); Interface Between Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary data Exchange
c. EIA 310-C (1982); Racks, Panels and Associated Equipment
d. EIA 330 (1968); Electrical Performance Standards for Closed Circuit Television Camera 525/60 Interlaced 2:1
e. EIA 375-A (1974) Electrical Performance Standards – direct view CCTV Monitors
f. EIA 445 (1980); Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices
g. EIA/TIA-455-3A FOTP-3 Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components

h. EIA/TIA-455-B Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
i.

5. Institute of Electrical and Electronics Engineers (IEEE)

a. IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
b. IEEE Std 100 (2000) The Authoritave Dictionary of IEEE Standards Terms
c. IEEE Std 142 (1991; Err 2006) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book (Color Book Series)
d. IEEE Std. 503 (1978) Measurement and Characterization of Diode-Type Cameras.
e. IEEE C2 (2005) National Electrical Safety Code
f. IEEE C62.41 (1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

6. International Organization for Standardization (ISO)

a. ISO 7810 (2003) Identification Cards – Physical Characteristics
b. ISO 7811-1 (2002) Identification Cards – Recording Technique - Part 1: Embossing
c. ISO 7811-2 (2001) Identification Cards – Recording Technique - Part 2: Magnetic Stripe - Low Coercivity
d. ISO/IEC 7811-5 (1995) Identification Cards – Recording Technique - Part 5: Location of Read-Write Magnetic Track - Track 3

7. International Telecommunications Union (ITU)

a. ITU V.34 (1998) Data Communication Over the Telephone Network: A Modem Operating at Data Signaling Rates of up to 33,600 bits for use on the General Switched Telephone Network and on Leased Point-to-Point Two-Wire Telephone Type Circuits
b. ITU V.42 (CORR 1 2003) Data Communications Over the Telephone Network: Error-Correcting Procedures for DCEs Using Asynchronous-to-Synchronous Conversion
c. ITU V.42 bis (1990) Data Communication over the Telephone Network: Data Compression Procedures for Data Circuit Terminating Equipment (DCE) Using Error Correction Procedures
d. ITU V.92 (AMD 2001, AMD 2002 and CORR 2003) Enhancements to Recommendation V.90 Series: V, with Amendments 1 and 2

8. National Electrical Manufacturers Association (NEMA)

a. NEMA 250 (2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

b. NEMA ICS 1 (2000; R 2005) Industrial Control and Systems: General Requirements
c. NEMA ICS 2 (2000; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
d. NEMA ICS 6 (1993; R 2006) Industrial Control and Systems: Enclosures

9. National Fire Protection Association (NFPA)

a. NFPA 70 (2005; TIA 2005); National Electrical Code
b. NFPA 72 (2007);– National Fire Alarm Code.
c. NFPA 101 Chapter 5 (1999); Life Safety Code
d. NFPA 262 (2007); Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
e. NFPA 730 (2006 or Newer); Guide for Premises Security
f. NFPA 731 (2006 or Newer); Standard for the Installation of Electronic Premises Security Systems

10. Security Industry Association

a. SIA BIO-01(2000 or Newer); Biometric Standard, Vocabulary for Testing
b. SIA CP-01 (2000 or Newer); Control Panel Standard
c. SIA DC-01 (1988 or Newer); Digital Communications Technical Report - Receiver-to- Computer Interface Protocol
d. SIA DC-03 (1990 or Newer); Digital Communications Standard - "SIA Format" Protocol - for Alarm System Communications
e. SIA DC-07 (2001); SIA Digital Communications Standard - Receiver-to-Computer Interface Protocol (Type 2) - for Central Station Equipment Communications

11. Society of Motion Picture and Television Engineers (SMPTE)

a. SMPTE 170M (2004) Television - Composite Analog Video Signal - NTSC for Studio Applications

12. Telecommunication Industry Association (TIA)

a. TIA-232-F (1997; R 2002); Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
b. ANSI/TIA/EIA 492AAAA-A (2002); Detail Specification for 62.5µm Core Diameter / 125µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
c. ANSI/TIA/EIA-526-14-A – Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant OFSTP-14A
d. ANSI/TIA/EIA-568-B.1 (2001 Addendums 2001, 2003, 2003, 2003, 2004, 2007) Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements

e. ANSI/TIA/EIA-568-B.2 (2002); Commercial Building Telecommunications Cabling Standard. Part 2: Balanced Twisted-Pair Cabling Components
f. ANSI/TIA/EIA-568-B.3 (2002); Commercial Building Telecommunications Cabling Standard. Part 3: Optical Fiber Cabling Components Standard
g. ANSI/TIA/EIA-569-B (2004); Commercial Building Standard for Telecommunications Pathways and Spaces
h. ANSI/TIA/EIA-598-B (2001); Optical Fiber Cable Color Coding
i. ANSI/TIA/EIA-604-2 (2002); Fiber Optic Connector Intermateability ST-Style Connectors
j. ANSI/TIA/EIA-604-3-A (2002); Fiber Optic Connector Intermateability SC-Style Connectors
k. ANSI/TIA/EIA-604-12(2002); FOCIS 3A Fiber Optic Connector Intermateability Standard
l. ANSI/TIA/EIA-606-A (2002); Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
m. ANSI/TIA/EIA TSB-67 (1995 or Newer); Transmission Performance Specifications for Field Testing of Unshielded Twisted- Pair (UTP) Cabling Systems - Draft
n. ANSI/T1A/E1A TSB-72 (1995 or Newer); Centralized Optical Fiber Cabling Guidelines - Draft.

13. Code of Federal Regulations

    a. 21 CFR 1020 (2006); Performance Standards for Ionizing Radiation Emitting Products
    b. 14 CFR 108.17 & 129.26 (2006);U.S. Federal Aviation Standards
    c. 29 CFR 1910.7 (2004); Definition and requirements for a nationally recognized testing
    d. 47 CFR 15 (2007); Radio Frequency Devices
    e. 47 CFR 68 (2006); Connection of Terminal Equipment to the Telephone Network

14. Underwriters Laboratories (UL) - The Contractor shall provide evidence of system compliance and shall clearly indicate any specific departures from the UL Listed configuration for the system provided.

    a. UL 6 (2004); Rigid Metal Conduit
    b. UL 50 (1995); Electrical Cabinets and Boxes
    c. UL 83 (2003); Thermoplastic-Insulated Wires and Cables
    d. UL 294 (1999; Rev thru Aug 2005) Access Control System Units
    e. UL 444 (2002); Communications Cables
    f. UL 464 (2003; Rev thru Oct 2003) Audible Signal Appliances
    g. UL 467 (2004); Standard for Grounding and Bonding Equipment
    h. UL 497B (2004); Protectors for Data Communication and Fire Alarm Circuits
    i. UL 609 (1996; Rev thru Mar 2005) Local Burglar Alarm Units and Systems
    j. UL 634 (2000); Connectors and Switches for Use with Burglar-Alarm Systems

k. UL 636 (1996; Rev thru Mar 2001) Holdup Alarm Units and Systems
l. UL 639 (1997; Rev thru Sep 2002) Intrusion Detection Units
m. UL 681 (1999; Rev thru Jan 2001) Installation and Classification of Burglar and Holdup Alarm Systems
n. UL 796 (2006); Printed-Wiring Boards
o. UL 797 (2004); Electrical Metallic Tubing -- Steel
p. UL 827 (1996; Rev thru Apr 1999) Central Station Alarm Services
q. UL 910 (1998); UL 910 UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
r. UL 969 (1995); Standard for Marking and Labeling Systems
s. UL 972 (2006);Burglary Resisting Glazing Material
t. UL 1037 (1999; Rev thru Nov 2004); Standard for Safety Antitheft Alarms and Devices
u. UL 1076 (1995; Rev thru Mar 2005); Standard for Safety Proprietary Burglar Alarm Units and Systems
v. UL 1410 (1991); Television Receivers and High Voltage Video Products
w. UL 1424 (2005); Standard for Cables for Power-Limited Fire-Alarm Circuits
x. UL 1492 (1996; R May 2004); Safety Audio-Video Products and Accessories
y. UL 1581 (2001); Reference Standard for Electrical Wires, Cables, and Flexible Cords
z. UL 1610 (1998; Rev thru Aug 2005); Central-Station Burglar-Alarm Units
aa. UL 1635 (1996; Rev thru Aug 2005); Digital Alarm Communicator System Units
bb. UL 1638 (2001; Rev thru Nov 2003); Visual Signaling Appliances - Private Mode Emergency and General Utility Signaling
cc. UL 1655 (1997); Standard for Community-Antenna Television Cables
dd. UL 1660 (2004); Liquid-Tight Flexible Nonmetallic Conduit
ee. UL 1666 (2007); Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
ff. UL 1981 (1994; Rev. 1999); Central Station Automation Systems
gg. UL 2050 (2003; 4th Edition); National Industrial Security Systems
hh. UL 2196 (2007); Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

15. Federal Communication Commission (FCC)

    a. FCC Part 15 (July 1986) rules and regulations; Radio Frequency Devices.

16. Federal Specifications (FS)

    a. WC-586 (Revised) conduit outlet boxes, bodies, and entrance caps electrical; cast metal.

1.5 SUMMARY

A. Section Includes:

1. Description of Work for Electronic Security Systems

2. Electronic security equipment coordination with relating Divisions

3. Submittal Requirements for Electronic Security

4. Miscellaneous Supporting equipment and materials for Electronic Security

5. Electronic security installation requirements.

B. This Section includes a security access control system, a component of the GE Facility Commander WNX v7.5 Security Management System consisting of a server, one or more networked workstation computers, operating system and application software, and field-installed security equipment. The SMS shall reside on the college's dedicated Montgomery College Facilities Network (MC F-Net). The security access system shall have the following:

1. Access Control:

a. Regulating access through doors, gates, and others access points specified in drawing documents.
b. Credential cards and readers.
c. Monitoring of field-installed devices.
d. Reporting.

2. Security:

a. Video and camera control.
b. Emergency communications systems.

1.6 DEFINITIONS

A. ACAM: Access Control and Alarm Monitoring

B. AGC: Automatic Gain Control.

C. B/W: Black and White.

D. BICSI: Building Industry Consulting Service International

E. CCD: Charge-coupled device.

F. Central Station: A PC with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.

G. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

H. CPU: Central processing unit.

I. Credential: Data assigned to an entity and used to identify that entity.

J. DGP: Data Gathering Panel

K. DVR: Digital Video Recorder

L. EMI: Electromagnetic interference.

M. EMT: Electric Metallic Tubing

N. ESS: Electronic Security System

O. File Server: A PC in a network that stores the programs and data files shared by users.

P. GFI: Ground fault interrupter.

Q. IDC: Insulation displacement connector.

R. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

S. I/O: Input/Output.

T. MCF-Net: Montgomery College Facilities Network

U. NIC: Network Intelligent Controller

V. Intrusion Zone: A space or area for which an intrusion must be detected and uniquely identified, the sensor or group of sensors assigned to perform the detection, and any interface equipment between sensors and communication link to central-station control unit.

W. LAN: Local area network.

X. LCD: Liquid-crystal display.

Y. LED: Light-emitting diode.

Z. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.

AA. LOD: Level of Detail

BB. LOE: Level of Effort

CC. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

DD. M-JPEG: Motion – Joint Photographic Experts Group.

EE. MPEG: Moving picture experts group.

FF. NEC: National Electric Code

GG. NEMA: National Electrical Manufacturers Association

HH. NFPA: National Fire Protection Association

II. NTSC: National Television System Committee.

JJ. NRTL: Nationally Recognized Testing Laboratory.

KK. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

LL. OSHEM: Office of Safety, Health and Environmental Management

MM. OTDR: Optical Time Domain Reflectometer

NN. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.

OO. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).

PP. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.

QQ. PIR: Passive infrared.

RR. RCDD: Registered Communications Distribution Designer.

SS. RF: Radio frequency.

TT. RFI: Radio-frequency interference.

UU. RIGID: Rigid conduit is galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded.

VV. ROM: Read-only memory. ROM data are maintained through losses of power.

WW. RS-232: An TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.

XX. RS-485: An TIA/EIA standard for multipoint communications.

YY. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

ZZ. SMS: Security Management System – A SMS is a software that incorporates multiple security subsystems (e.g., access control, intrusion detection, closed circuit television, intercom) into a single platform and graphical user interface.

AAA. Standard Intruder: A person who weighs 45 kg (100 lb.) or less and whose height is 1525 mm (60 in) or less; dressed in a long-sleeved shirt, slacks, and shoes.

BBB. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

CCC. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

DDD. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

EEE. TWAIN: (Technology without an Interesting Name.) A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

FFF. UPS: Uninterruptible Power Supply

GGG. UTP: Unshielded Twisted Pair

HHH. VPN: Virtual Private Network

III. WAN: Wide Area Network.

JJJ. WAV: The digital audio format used in Microsoft Windows.

KKK. Windows: Operating system by Microsoft Corporation.

LLL. Workstation: A PC with software that is configured for specific limited security system functions.

MMM. WYSIWYG: (What You See Is What You Get.) Text and graphics appear on the screen the same as they will print.

1.7 GENERAL ARRANGEMENT OF CONTRACT DOCUMENTS

A. The Contract Documents supplement to this specification indicates approximate locations of equipment. The installation and/or locations of the equipment and devices shall be governed by the intent of the design; specification and Contract Documents, with due regard to actual site conditions, recommendations, ambient factors affecting

the equipment and operations in the vicinity. The Contract Documents are diagrammatic and do not reveal all offsets, bends, elbows, components, materials, and other specific elements that may be required for proper installation. If any departure from the contract documents is deemed necessary, or in the event of conflicts, the Contractor shall submit details of such departures or conflicts in writing to the owner or owner's representative for his or her comment and/or approval before initiating work.

B. Anything called for by one of the Contract Documents and not called for by the others shall be of like effect as if required or called by all, except if a provision clearly designed to negate or alter a provision contained in one or more of the other Contract Documents shall have the intended effect. In the event of conflicts among the Contract Documents, the Contract Documents shall take precedence in the following order: the Form of Agreement; the Supplemental General Conditions; the Special Conditions; the Specifications with attachments; and the drawings.

1.8 SUBMITTALS

A. General: Submittals shall be in full compliance of the Contract Documents. All submittals shall be provided in accordance with this section. Submittals lacking the breath or depth these requirements will be considered incomplete and rejected. Submissions are considered multidisciplinary and shall require coordination with applicable divisions to provide a complete and comprehensive submission package. Additional general provisions are as follows:

1. The Contractor shall schedule submittals in order to maintain the project schedule. For coordination drawings refer to 01000 Specifications - Design Submittal Procedures, which outline basic submittal requirements and coordination. 01000 Specifications shall be used in conjunction with this section.

2. The Contractor shall identify variations from requirements of Contract Documents and state product and system limitations, which may be detrimental to successful performance of the completed work or system.

3. Each package shall be submitted at one (1) time for each review and include components from applicable disciplines (e.g., electrical work, architectural finishes, door hardware, etc.) which are required to produce an accurate and detailed depiction of the project.

4. Manufacturer's information used for submittal shall have pages with items for approval tagged, items on pages shall be identified, and capacities and performance parameters for review shall be clearly marked through use of an arrows or highlighting. Provide space for Owner and Consultant review stamps.

5. Technical Data Drawings shall be in the latest version of AutoCAD®, drawn accurately, and in accordance with Montgomery Community College CAD Standards. **FREEHAND SKETCHES OR COPIED VERSIONS OF THE CONSTRUCTION DOCUMENTS WILL NOT BE ACCEPTED**. **THE**

CONTRACTOR SHALL NOT REPRODUCE CONTRACT DOCUMENTS OR COPY STANDARD INFORMATION AS THE BASIS OF THE TECHNICAL DATA DRAWINGS. If departures from the technical data drawings are subsequently deemed necessary by the Contractor, details of such departures and the reasons thereof shall be submitted in writing to the Owner for approval before the initiation of work.

6. Packaging: The Contractor shall organize the submissions according to the following packaging requirements.

   a. Binders: For each manual, provide heavy duty, commercial quality, durable three (3) ring vinyl covered loose leaf binders, sized to receive 8.5 x 11 in paper, and appropriate capacity to accommodate the contents. Provide a clear plastic sleeve on the spine to hold labels describing the contents. Provide pockets in the covers to receive folded sheets.

      1) Where two (2) or more binders are necessary to accommodate data; correlate data in each binder into related groupings according to the Project Manual table of contents. Cross-referencing other binders where necessary to provide essential information for communication of proper operation and/or maintenance of the component or system.
      2) Identify each binder on the front and spine with printed binder title, Project title or name, and subject matter covered. Indicate the volume number if applicable.

   b. Dividers: Provide heavy paper dividers with celluloid tabs for each Section. Mark each tab to indicate contents.
   c. Protective Plastic Jackets: Provide protective transparent plastic jackets designed to enclose diagnostic software for computerized electronic equipment.
   d. Text Material: Where written material is required as part of the manual use the manufacturer's standard printed material, or if not available, specially prepared data, neatly typewritten on 8.5 inches by 11 inches 20 pound white bond paper.
   e. Drawings: Where drawings and/or diagrams are required as part of the manual, provide reinforced punched binder tabs on the drawings and bind them with the text.

      1) Where oversized drawings are necessary, fold the drawings to the same size as the text pages and use as a foldout.
      2) If drawings are too large to be used practically as a foldout, place the drawing, neatly folded, in the front or rear pocket of the binder. Insert a type written page indicating the drawing title, description of contents and drawing location at the appropriate location of the manual.
      3) Drawings shall be sized to ensure details and text is of legible size. Text shall be no less than 1/16” tall.

f. Manual Content: In each manual include information specified in the individual Specification section, and the following information for each major component of building equipment and controls:

1) General system or equipment description.
2) Design factors and assumptions.
3) Copies of applicable Shop Drawings and Product Data.
4) System or equipment identification including: manufacturer, model and serial numbers of each component, operating instructions, emergency instructions, wiring diagrams, inspection and test procedures, maintenance procedures and schedules, precautions against improper use and maintenance, repair instructions, sources of required maintenance materials and related services, and a manual index.

g. Binder Organization: Organize each manual into separate sections for each piece of related equipment. At a minimum, each manual shall contain a title page, table of contents, copies of Product Data supplemented by drawings and written text, and copies of each warranty, bond, certifications, and service Contract issued. Refer to Group I through V Technical Data Package Submittal requirements for required section content.

h. Title Page: Provide a title page as the first sheet of each manual to include the following information; project name and address, subject matter covered by the manual, name and address of the Project, date of the submittal, name, address, and telephone number of the Contractor, and cross references to related systems in other operating and/or maintenance manuals.

i. Table of Contents: After the title page, include a type written table of contents for each volume, arranged systematically according to the Project Manual format. Provide a list of each product included, identified by product name or other appropriate identifying symbols and indexed to the content of the volume. Where more than one (1) volume is required to hold data for a particular system, provide a comprehensive table of contents for all volumes in each volume of the set.

j. General Information Section: Provide a general information section immediately following the table of contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the installer and maintenance Contractor. In addition, list a local source for replacement parts and equipment.

k. Drawings: Provide specially prepared drawings where necessary to supplement the manufacturers printed data to illustrate the relationship between components of equipment or systems, or provide control or flow diagrams. Coordinate these drawings with information contained in Project Record Drawings to assure correct illustration of the completed installation.

l. Manufacturer’s Data: Where manufacturer's standard printed data is included in the manuals, include only those sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where more than one (1) item in tabular format

is included, identify each item, using appropriate references from the Contract Documents. Identify data that is applicable to the installation and delete references to information which is not applicable.

m. Where manufacturer's standard printed data is not available and the information is necessary for proper operation and maintenance of equipment or systems, or it is necessary to provide additional information to supplement the data included in the manual, prepare written text to provide the necessary information. Organize the text in a consistent format under a separate heading for different procedures. Where necessary, provide a logical sequence of instruction for each operating or maintenance procedure. Where similar or more than one product is listed on the submittal the Contractor shall differentiate by highlighting the specific product to be utilized.

n. Calculations: Provide a section for circuit and panel calculations.

o. Certifications: Provide section for Contractor's manufacturer certifications.

7. Contractor Review: Review submittals prior to transmittal. Determine and verify field measurements and field construction criteria. Verify manufacturer's catalog numbers and conformance of submittal with requirements of contract documents. Return non-conforming or incomplete submittals with requirements of the work and contract documents. Apply Contractor's stamp with signature certifying the review and verification of products occurred, and the field dimensions, adjacent construction, and coordination of information is in accordance with the requirements of the contract documents.

8. Resubmission: Revise and resubmit submittals as required within 15 calendar days of return of submittal. Make resubmissions under procedures specified for initial submittals. Identify all changes made since previous submittal.

9. Product Data: Within 15 calendar days after execution of the contract, the Contractor shall submit for approval a complete list of all of major products proposed for use. The data shall include name of manufacturer, trade name, model number, the associated contract document section number, paragraph number, and the referenced standards for each listed product.

B. Group 1 Technical Data Package: Group I Technical Data Package shall be one submittal consisting of the following content and organization. The data package shall include the following:

1. Section I - Drawings:

a. General – Drawings shall conform to Montgomery Community College CAD Standards. All text associated with security details shall be 1/8" tall for AutoCAD™ drawings.

b. Cover Sheet – Cover sheet shall consist of Project Title and Address, Project Number, Area and Vicinity Maps.

c. General Information Sheets – General Information Sheets shall consist of General Notes, Abbreviations, Symbols, Project Phasing, and Sheet Index.

d. Floor Plans – Floor plans shall be produced from the Architectural backgrounds issued in the Construction Documents. The contractor shall receive floor plans from the prime A/E to develop these drawing sets. Security devices shall be placed on drawings in scale. All text associated with security details shall be 1/8" tall AutoCAD™ drawings. Floor plans shall identify the following:

    1) security devices by symbol,
    2) wire & cable types and counts
    3) conduit sizing and routing
    4) conduit riser systems
    5) device and area detail call outs

e. Architectural details – Architectural details shall be produced for each device mounting type.

f. Riser Diagrams – Contractor shall provide a riser diagram indicating riser architecture and distribution of the SMS throughout the facility (or area in scope).

g. Block Diagrams – Contractor shall provide a block diagram for the entire system architecture and interconnections with SMS subsystems. Block diagram shall identify SMS subsystem (e.g., electronic entry control, intrusion detection, closed circuit television, intercom, and other associated subsystems) integration; and data transmission and media conversion methodologies.

h. Interconnection Diagrams – Contractor shall provide interconnection diagram for each sensor, and device component. Interconnection diagram shall identify termination locations, standard wire detail to include termination schedule. Diagram shall also identify interfaces to other systems such as elevator control, fire alarm systems, and security management systems.

i. Security Details –

    1) Panel Assembly Detail – Provide a detail for each panel assembly type.
    2) Device Mounting Details – Provide detailed mounting drawing for each security device (electronic entry control, intrusion detection, video surveillance and assessment, and intercom systems) for each type of wall and ceiling configuration in project. Device details shall include device, mounting detail, wiring and conduit routing. Each detail shall incorporate project architectural details.
    3) Details of connections to power supplies and grounding
    4) Details of surge protection device installation
    5) Sensor detection patterns – Each system sensor shall have associated detection patterns.
    6) Equipment Rack Detail – For each equipment rack, provide a scaled detail of the equipment rack location and rack space utilization. Use of BICSI wire management standards shall be employed to identify

wire management methodology. Transitions between equipment racks shall be shown to include use vertical and horizontal ladder rack system.

7) Equipment Room – Equipment room details shall provide architectural, electrical, mechanical, plumbing, IT/Data and associated equipment and device placements both vertical and horizontally.

j. Electrical Panel Schedule – Electrical Panel Details shall be provided for all SMS systems electrical power circuits. Panel details shall be provided identifying panel type (Standard, Emergency Power, Emergency/Uninterrupted Power Source, and Uninterrupted Power Source Only), panel location, circuit number, and circuit amperage rating.

k. Door Schedule – A door schedule shall be developed for each door equipped with electronic security components. At a minimum, the door schedule shall be coordinated with Division 08 work and include the following information:

1) Item Number
2) Door Number (Derived from A/E Drawings)
3) Floor Plan Sheet Number
4) Standard Detail Number
5) Door Description (Location/Room Name)
6) Data Gathering Panel Input Number
7) Door Position or Monitoring Device Type & Model Number
8) Lock Type, Model Number & Power Input/Draw (standby/active)
9) Card Reader Type & Model Number
10) Shunting Device Type & Model Number
11) Sounder Type & Model Number
12) Manufacturer
13) Misc. devices as required

a) Delayed Egress Type & Model Number
b) Intercom
c) Camera
d) Electric Transfer Hinge
e) Electric Pass-through device

14) Remarks column indicating special notes or door configurations

l. Camera Schedule - A camera schedule shall be developed for each camera. Contractors shall coordinate with the Owner to determine camera starting numbers and naming conventions. All drawings shall identify wire and cable standardization methodology. Color coding of all wiring conductors and jackets is required and shall be communicated consistently throughout the drawings package submittal. At a minimum, the camera schedule shall include the following information:

1) Item Number
2) Camera Number
3) Naming Conventions
4) Description of Camera Coverage
5) Camera Location
6) Floor Plan Sheet Number
7) Camera Type
8) Mounting Type
9) Standard Detail Reference
10) Power Input & Draw
11) Power Panel Location
12) Remarks Column for Camera

2. Section II – Network Intelligent Controller Documentation Package

   a. Not Required

3. Section III - Construction Mock-up: In areas with exposed EMT/Conduit Raceways, contractor shall conceal raceway as much as practical and unobtrusively. In addition, historic significance must be considered to determine installation means and methods for approval by the owner.

4. Section IV - Manufacturers' Data: The data package shall include manufacturers' data for all materials and equipment, including sensors, local processors and console equipment provided under this specification.

5. Section V - System Description and Analysis: The data package shall include system descriptions, analysis, and calculations used in sizing equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance requirements of this specification. The data package shall include the following:

   a. Central processor memory size; communication speed and protocol description; rigid disk system size and configuration; flexible disk system size and configuration; back-up media size and configuration; alarm response time calculations; command response time calculations; start-up operations; expansion capability and method of implementation; sample copy of each report specified; and color photographs representative of typical graphics.
   b. Software Data: The data package shall consist of descriptions of the operation and capability of the system, and application software as specified.
   c. Overall System Reliability Calculations: The data package shall include all manufacturers' reliability data and calculations required to show compliance with the specified reliability.

6. Section VI – Certifications & References: All specified manufacturer's certifications shall be included with the data package. Contractor shall provide Project references as outlined in Paragraph 1.11 A "Contractor Qualifications".

C. Group II Technical Data Package

1. Not required.

D. Group III Technical Data Package

1. Not required.

2. .

E. Group IV Technical Data Package

1. Training Documentation

a. Familiarization training shall be provided for new equipment or systems. Training shall include "End-User" system familiarization, basic system operations and credential production. All documentation, including manuals, software, key systems, and full system administration rights shall be turned over to the designated system administrator. Lesson plans and training manuals training shall be oriented to type of training to be provided. See "Familiarization Training" for specific training requirements.

2. System Configuration and Data Entry:

a. The contractor is responsible for providing all system configuration and data entry for the SMS and subsystems (e.g., video matrix switch, intercom, digital video recorders). All data entry shall be performed to Montgomery Community College standards & guidelines. The Contractor is responsible for participating in all meetings with the Ownert to compile the information needed for data entry. These meetings shall be established at the beginning of the project and incorporated in to the project schedule as a milestone task. The contractor shall be responsible for all data collection, data entry, and system configuration. The contractor shall collect, enter, & program and/or configure the following components:

1) Access control system components
2) Video surveillance, control and recording systems
3) Intercom systems components
4) All other security subsystems shown in the contract documents

b. The Contractor is responsible for compiling the card access database for the Owner's employees, including programming reader configurations, access shifts, schedules, exceptions, card classes and card enrollment databases.

c. Refer to Part 4 for system programming requirements and planning guidelines.

3. Graphics: Based on CAD as-built drawings developed for the construction project, create all map sets showing locations of all alarms and field devices. Graphical maps of all alarm points installed under this contract including perimeter and exterior alarm points shall be delivered with the system. The Contractor shall create and install all graphics needed to make the system operational. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and all other pertinent information in the Contractor's possession to complete the graphics. The Contractor shall identify and request from the Owner, any additional data needed to provide a complete graphics package. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 8" x 10" of each type of graphic to be used for the completed Security system. The graphics examples shall be delivered to the Owner for review and approval at least 90 calendar days prior to the scheduled date the Contractor requires them.

F. Group V Technical Data Package: Final copies of the manuals shall be delivered to the Owner as part of the acceptance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each sub-contractor installing equipment or systems, as well as the nearest service representatives for each item of equipment for each system. The manuals shall include a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Two (2) hard-copies and one (1) soft copy on CD of each item listed below shall be delivered as a part of final systems acceptance.

1. Functional Design Manual: The functional design manual shall identify the operational requirements for the entire system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes. Manufacturer developed literature may be used; however, shall be produced to match the project requirements.

2. Equipment Manual: A manual describing all equipment furnished including:

   a. General description and specifications; installation and checkout procedures; equipment electrical schematics and layout drawings; system schematics and layout drawings; alignment and calibration procedures; manufacturer's repair list indicating sources of supply; and interface definition.

3. Software Manual: The software manual shall describe the functions of all software and include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

a. Definition of terms and functions; use of system and applications software; procedures for system initialization, start-up, and shutdown; alarm reports; reports generation, database format and data entry requirements; directory of all disk files; and description of all communications protocols including data formats, command characters, and a sample of each type of data transfer.

4. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system, including:

   a. Computers and peripherals; system start-up and shutdown procedures; use of system, command, and applications software; recovery and restart procedures; graphic alarm presentation; use of report generator and generation of reports; data entry; operator commands' alarm messages, and printing formats; and system access requirements.

5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, recommend schedules, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

6. Spare Parts & Components Data: At the conclusion of the Contractor's work, the Contractor shall submit to the Owner a complete list of the manufacturer's recommended spare parts and components required to satisfactorily maintain and service the systems, as well as unit pricing for those parts and components.

7. Operation, Maintenance & Service Manuals: The Contractor shall provide two (2) complete sets of operating and maintenance manuals in the form of an instructional manual for use by Montgomery Community College Guard Force personnel. The manuals shall be organized into suitable sets of manageable size. Where possible, assemble instructions for similar equipment into a single binder. If multiple volumes are required, each volume shall be fully indexed and coordinated.

8. Equipment and Systems Maintenance Manual: The Contractor shall provide the following descriptive information for each piece of equipment, operating system, and electronic system:

   a. Equipment and/or system function.
   b. Operating characteristics.
   c. Limiting conditions.
   d. Performance curves.
   e. Engineering data and test.
   f. Complete nomenclature and number of replacement parts.
   g. Provide operating and maintenance instructions including assembly drawings and diagrams required for maintenance and a list of items recommended to stock as spare parts.

h. Provide information detailing essential maintenance procedures including the following: routine operations, trouble shooting guide, disassembly, repair and re-assembly, alignment, adjusting, and checking.
i. Provide information on equipment and system operating procedures, including the following; start-up procedures, routine and normal operating instructions, regulation and control procedures, instructions on stopping, shut-down and emergency instructions, required sequences for electric and electronic systems, and special operating instructions.
j. Manufacturer equipment and systems maintenance manuals are permissible.

9. Project Redlines: During construction, the Contractor shall maintain an up-to-date set of construction redlines detailing current location and configuration of the project components. The redline documents shall be marked with the words 'Master Redlines' on the cover sheet and be maintained by the Contractor in the project office. The Contractor will provide access to redline documents anytime during the project for review and inspection by the Owner or authorized representative. Master redlines shall be neatly maintained throughout the project and secured in the contractor's onsite project office. Any project component or assembly that is not installed in strict accordance with the drawings shall be so noted on the drawings. Prior to producing Record Construction Documents, the contractor will submit the Master Redlines document to the Owner for review and approval of all changes or modifications to the documents. Each sheet shall have Owner's initials indicating authorization to produce "As Built" documents. Field drawings shall be used for data gathering & field changes. These changes shall be made to the master redline documents daily. Field drawings shall not be considered "master redlines".

10. Record Specifications: The Contractor shall maintain one (1) copy of the Project Specifications, including addenda and modifications issued, for Project Record Documents. The Contractor shall mark the Specifications to indicate the actual installation where the installation varies substantially from that indicated in the Contract Specifications and modifications issued. (Note related Project Record Drawing information where applicable). The Contractor shall pay particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later. Upon completion of the mark ups, the Contractor shall submit record Specifications to the Owner. As with master relines, Contractor shall maintain record specifications for Owner review and inspection at anytime.

11. Record Product Data: The Contractor shall maintain one (1) copy of each Product Data submittal for Project Record Document purposes. The Data shall be marked to indicate the actual product installed where the installation varies substantially from that indicated in the Product Data submitted. Significant changes in the product delivered to the site and changes in manufacturer's instructions and recommendations for installation shall be included. Particular attention will be given to information on concealed products and installations that cannot be readily identified or recorded later. Note related Change Orders and mark up of

Record Construction Documents, where applicable. Upon completion of mark up, submit a complete set of Record Product Data to the Owner.

12. Miscellaneous Records: The Contractor shall maintain one (1) copy of miscellaneous records for Project Record Document purposes. Refer to other Specifications for miscellaneous record-keeping requirements and submittals concerning various construction activities. Before substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Categories of requirements resulting in miscellaneous records include, a minimum of the following:

    a. Certificates received instead of labels on bulk products.
    b. Testing and qualification of tradesmen. ("Contractor's Qualifications")
    c. Documented qualification of installation firms.
    d. Load and performance testing.
    e. Inspections and certifications.
    f. Final inspection and correction procedures.
    g. Project schedule

13. Record Construction Documents (Record As-Built)

    a. Upon project completion, the Contractor shall submit the project master redlines to the Owner prior to development of Record construction documents. The Owner shall be given a minimum of thirty (30) days to review and determine the adequacy of the master redlines. If the master redlines are found suitable by the Owner, the Owner will initial and date each sheet and turn the redlines over to the contractor for "as-built" development.
    b. The Contractor shall provide the Owner a complete set of "as-built" drawings and original master redlined marked "as-built" blue-line in the latest version of AutoCAD drawings unlocked on CD or DVD. The as-built drawing shall include security device number, security closet connection location, network intelligent controller number, and input or output number as applicable. All corrective notations made by the Contractor shall be legible when submitted to the Owner. If, in the opinion of the Owner, any redlined notation that is not legible, shall be returned to the Contractor for re-submission at no extra cost to the Owner. The Contractor shall organize the Record Drawing sheets into manageable sets bound with durable paper cover sheets with suitable titles, dates, and other identifications printed on the cover. The submitted "as-builts" shall be in editable formats and the ownership of the drawings shall be fully relinquished to the Montgomery Community College.
    c. Where feasible, the individual or entity that obtained record data, whether the individual or entity is the installer, sub-contractor, or similar entity, is required to prepare the mark up on Record Drawings. Accurately record the information in a comprehensive drawing technique. Record the data when possible after it has been obtained. For concealed installations, record and check the mark up before concealment. At the time of substantial

completion, submit the Record Construction Documents to the Owner. The Contractor shall organize into bound and labeled sets for the Owner's continued usage. Provide device, conduit, and cable lengths on the conduit drawings. Exact in-field conduit placement/routings shall be shown. All conduits shall be illustrated in their entire length from termination in security closets; no arrowed conduit runs shall be shown. Pull box and junction box sizes are to be shown if larger than 4".

1.9 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic security equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required heights.

4. Ensure raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate the installation of required supporting discipline devices placement and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate the locations of access panels and doors for electronic security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

E. Contractor shall coordinate as needed with all related Divisions.

1.10 QUALITY ASSURANCE

A. Contractor Qualifications

1. The Contractor or Security Sub-Contractor shall be a licensed Security Contractor with a minimum of five (5) years experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the Security Management System's (SMS) manufacturer. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system

components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project. The Owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system. The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the SMS. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility. The facility shall be located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures. The Owner reserves the option of surveying the company's facility to verify the service inventory and presence of a local service organization.

2. The Contractor shall provide proof project superintendent is a BICSI Certified Commercial Installer Level 1, Level 2, or Technician to provide oversight of the project.

3. Cable installer must have on staff a BICSI certified Registered Communication Distribution Designer (RCDD). The staff member shall provide consistent oversight of the project cabling throughout design, layout, installation, termination and testing.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

C. Source Limitations: Obtain Central Station, workstations, Controllers, Identifier readers, and all software through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Experience

1. The Contractor shall submit written proof that the following experience requirements are being met.

   a. Hardware Manufacturer's Experience: All system components shall be produced by manufacturers who have been regularly engaged in the production of electronic security system components of the types to be installed for at least five (5) years.

b. Software Manufacturer's Experience: All system and application software shall be produced by manufacturers who have been regularly engaged in the production of electronic security system and application software of similar type and complexity as the specified system for at least five (5) years. Experience shall include museum or similar experience in cultural facilities and cultural storage and handling facilities.

c. System Installer Experience: The system shall be installed by a Contractor who has been regularly engaged in the installation of electronic security system equipment of similar type and complexity.

F. Manufacturers' Representatives

1. The Contractor shall retain a manufacturers' technical representative or technician to consult on equipment selection, installation, testing, and training personnel. The manufacturers' technical representative or technician shall be thoroughly experienced in the installation and operation of the system being provided under this contract with no less than five (5) continuous years of technical experience.

G. Material & Workmanship

1. Unless otherwise specifically provided under this contract, all equipment, material and articles to be incorporated in the work shall be new and of the most suitable grade for the purposes intended. References to any equipment, material, article or patented process, by trade name, make or catalog number shall be regarded as establishing a standard of performance and quality, and shall not be construed as limiting competition. The Contractor may, at his or her option, use any equipment, material, article, or process which, in the judgment of the Owner, is equivalent to or better than that specified. When required by this contract or when called for by the Owner, the Contractor shall furnish the name of the manufacturer, model number, and other identifying data and information that reflects the performance, capacity, nature and rating of the electrical, mechanical, and other equipment that the Contractor contemplates incorporating in the work to the Owner for approval. When so directed, the Contractor shall submit samples for approval at the Contractor's expense. Equipment, materials and articles installed or used without the required approval shall be at the Contractor's risk of rejection. Warranties of all work and installed products shall be according to the Contract General Provisions. The Contractor shall be responsible for assuring the compatibility of new systems with Montgomery Community College's pre-existing card format and GE Security Management Systems with Network Host/Node Capability.

1.11 MAINTENANCE & SERVICE

A. General Requirements: The Contractor shall provide all services required and equipment necessary to maintain the entire integrated electronic security system in an operational state as specified for a period of one (1) year after formal written acceptance of the system. The Contractor shall provide all necessary material required for

performing scheduled adjustments or other non-scheduled work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other non-scheduled work. See also General Project Requirements.

B. Description of Work: The adjustment and repair of the security system includes all software updates, panel firmware, and the following new items computers equipment, communications transmission equipment and data transmission media (DTM), local processors, security system sensors, access control equipment, facility interface, signal transmission equipment, and video equipment.

C. Personnel: Service personnel shall be certified in the maintenance and repair of the selected type of equipment and qualified to accomplish all work promptly and satisfactorily. The Owner shall be advised in writing of the name of the designated service representative, and of any change in personnel. The Owner shall be provided copies of system manufacturer certification for the designated service representative.

D. Schedule of Work: The work shall be performed during regular working hours, Monday through Friday, excluding holidays. These inspections shall include:

1. The Contractor shall perform two (2) minor inspections at six (6) month intervals or more if required by the manufacturer, and two (2) major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.

    a. Minor Inspections shall include visual checks and operational tests of all console equipment, peripheral equipment, local processors, sensors, electrical and mechanical controls, and adjustments on printers.
    b. Major Inspections shall include all work described for Minor Inspections and the following: clean all system equipment and local processors including interior and exterior surfaces; perform diagnostics on all equipment; operational tests of the CPU, switcher, peripheral equipment, recording devices, monitors, picture quality from each camera; check, walk test, and calibrate each sensor; run all system software diagnostics and correct all problems; and resolve any previous outstanding problems.

E. Emergency Service: The Owner shall initiate service calls whenever the system is not functioning properly. The Contractor shall provide the Owner with an emergency service center telephone number. The emergency service center shall be staffed 24 hours a day 365 days a year. Montgomery Community College shall have sole authority for determining catastrophic and non-catastrophic system failures within parameters stated in General Project Requirements.

1. For catastrophic system failures, the Contractor shall provide same day four (4) hour service response with a defect correction time not to exceed eight (8) hours from arrival on site. Catastrophic system failures are defined as any system failure that the Owner determines will place the facilityat increased risk.

2. For non-catastrophic failures, the Contractor within eight (8) hours with a defect correction time not to exceed 24 hours from notification.

F. Operation: Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable portions of the performance verification test.

G. Records & Logs: The Contractor shall maintain records and logs of each task and organize cumulative records for each component and for the complete system chronologically. A continuous log shall be submitted for all devices. The log shall contain all initial settings, calibration, repair, and programming data. Complete logs shall be maintained and available for inspection on site, demonstrating planned and systematic adjustments and repairs have been accomplished for the system.

H. Work Request: The Contractor shall separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. The Contractor shall deliver a record of the work performed within five (5) working days after the work was completed.

I. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the Owner. Any modifications made to the system shall be incorporated into the operation and maintenance manuals and other documentation affected.

J. Software: The Contractor shall provide all software updates when approved by Owner from the manufacturer during the installation and 12-month warranty period and verify operation of the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and incorporated into the operations and maintenance manuals and software documentation. There shall be at least one (1) scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Manufacturer's software. All software changes shall be recorded in a log maintained in the unit control room. An electronic copy of the software update shall be maintained within the log. At a minimum, the contractor shall provide a description of the modification, when the modification occurred, and name and contact information of the individual performing the modification. The log shall be maintained in a white 3 ring binder and the cover marked "SOFTWARE CHANGE LOG".

1.12 SYSTEM DESCRIPTION

A. System shall consist of a System Software, System Server, PC-based Central Station, one or more networked PC-based workstations, and field-installed Controllers, connected by a high-speed electronic data transmission network.

B. System Software shall be GE Facility Commander WNX v7.5 Security Management System.

C. The system server shall reside in the Security Operations Center located in the Golden Rod

1. System Software: Based on 64 bit, Microsoft Windows operating system. central-station, workstation operating system, server operating system, and application software. Software shall have the following capabilities:

a. Multi-user multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations.
b. Graphical user interface (GUI) to show pull-down menus and a menu tree format which complies with interface guidelines of Microsoft Windows operating system.
c. System license shall be for the entire system and include capability for future additions which are within the indicated system size limits specified in this Section.
d. System shall have open architecture so it allows importing and exporting of data and interfacing with other systems which are compatible with Microsoft Windows operating system.
e. Password-protected operator login and access.

D. Network connecting the Central Station and workstations shall be a LAN using Microsoft Windows-based TCP/IP with a capacity of connecting up to 99 workstations.

E. Network(s) connecting PCs and Controllers shall consist of one or more of the following:

1. Local area, IEEE 802.3 Fast Ethernet 100 BASE-TX star topology network based on TCP/IP.

2. Direct-connected, RS-232 cable from the COM port of the Central Station to the first Controller, then RS-485 to interconnect the remainder of the Controllers at that Location.

3. Dial-up modem connection using a standard dial-up telephone line.

1.13 PERFORMANCE REQUIREMENTS

A. The SMS shall use a single database for access-control functions.

B. Distributed Processing: System shall be a fully distributed processing system so information, including time, date, valid codes, access levels, and similar data is downloaded to Controllers so each Controller makes access-control decisions for that Location. Do not use intermediate Controllers for access control. If communications to Central Station are lost, all Controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the Central Station.

C. Cardholder records - 250,000 maximum.

D. Card readers - 2048 maximum per server.

E. Alarm input points - 32,768 maximum per server.

F. Relay outputs - 20,000 maximum.

G. Client workstations - 64.

H. Operator passwords – 512.

I. Interface with up to 512 NICs per server.

J. Up to 2048 security areas (controlled areas) per server.

K. Time intervals – 255.

L. 255 time schedules.

M. 128 user-defined cardholder fields and 128 visitor fields.

N. 128 data fields per cardholder.

O. 16 alarm priorities.

P. 32 user-defined alarm categories.

Q. 512 action/instruction text messages.

R. Global and local, hard, soft and timed anti-passback/anti-tailgate capability.

S. Configurable alarm-to-relay linking, downloaded to field controllers for local operation.

T. Configurable automatic time zone controlled commands, downloaded to the field controller for automatic local operation.

U. Configurable automatic, time controlled report generation and/or disk backup commands.

V. Visitor management and badging utility.

W. History/audit trail.

X. Ability to respond to access requests/alarm conditions before and during download to networked intelligent controllers.

Y. Automatic card activation and deactivation.

Z. Global and local alarm masking by operator or cardholder.

AA. Access activity analysis by card reader.

BB. High integrity dial-up capability to support access control panels and readers at remotely located sites via dial-up communication over public switched telephone

network, and to download database and upload transaction history based on operator commands. This feature shall provide the capability to segregate dial-up modem ports for Alarm Only reception, and for uploading and downloading database and transaction history information, so that even if all the upload/download ports are in use, the remote dial-up NICs can establish communication through Alarm Only modem ports to annunciate alarm conditions. The memory systems and functionality of the remote NICs shall be such that data corruption during database download, or interrupted communications during download shall not interfere with the ability of the remote NICs to continue to operate normally using database information previously downloaded to it.

CC. Capability to define within the system up to 127 variable card formats and have each card reader able to read three separate formats.

DD. Integrated photo-badging system incorporating a complete multi-layer, drag and drop, WYSIWYG, database keyed badge design facility, editor, and drawing package. The system must be capable of allowing enrollment facilities at any designated workstation, and displaying photo-images of cardholders at any workstation on an individual system.

EE. The system shall be capable of interfacing through NICs to keypads or card reader/keypad combinations with LCD displays allowing the system to operate as a proprietary burglar alarm system for designated security areas. The system shall provide delayed alarm reporting and masking facilities using these devices so that arming and disarming of security areas is delayed for a preset period. This will allow personnel entering an area to have the opportunity to disarm (mask) the alarm reporting facility by entering a code into the keypad, entering a card or both. During this entry delay period the LCD/keypad/card reader device shall emit an audible tone until the area is disarmed (masked). The system will allow the user to arm (unmask) the system before leaving the designated are, by entering data on the keypad, using a card or both, and the display shall provide information concerning the status of any unsecured alarm points in the area. Once the security area has been armed, the device will emit an audible tone for a predetermined time, and delay reporting alarm status for this same time to allow the occupant time to exit the secured area.

FF. The system shall provide a direct RS-232 Data interface for control of CCTV Sub-systems utilizing designated switching devices.

GG. The System shall provide local elevator cab control software as a standard feature.

HH. Optional host upload capability to import data from external computer systems and databases.

II. Optional monitor point verification program supporting the ability to walk test alarmed areas and create reports of the results of the test during on-line operation.

JJ. Optional area loading capability.

KK. Optional two man rule functionality using single card reader, dual card reader or combination of card reader and workstation operator.]

LL. Optional radio paging capability to report alphanumerically alarm conditions to designated security personnel through a radio pager interface with the Visiplex V3100 paging system..

MM. Capability to support multiple –Variable card formats].

NN. Optional Multiple Server control (Enterprise) capability to allow multiple independent ACAM systems to be linked by local or wide area networks or T1 links, to allow sharing of database information and password protected control of each independent system from any server or workstation on any of the systems on the network. Must include capability to route alarm information between systems based on operator command.

OO. Optional partitioned database capabilities to provided control and access to specific card records, security areas, alarm points and relay points based on group assignments.

PP. Optional guard tour control and monitoring] of at least 64 guard tours.

QQ. Capability to support multiple site and facility codes at card readers.

RR. Capability to support temporary badge operation.

SS. Capability to support biometric access control and verification readers.

TT. Capability to support TDES encrypted communications between ACAM servers and NICs.

UU. Capability to mask and unmask security areas globally from a single card reader/keypad with LCD display prompts.

VV. System Network Requirements:

1. Interconnect system components and provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.

2. Communication shall not require operator initiation or response, and shall return to normal after partial or total network interruption such as power loss or transient upset.

3. System shall automatically annunciate communication failures to the operator and identify the communication link that has experienced a partial or total failure.

4. Communications Controller may be used as an interface between the Central Station display systems and the field device network. Communications Controller shall provide functions required to attain the specified network communications performance.

WW. Central Station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central Station shall control system networks to

interconnect all system components, including workstations and field-installed Controllers.

XX. Field equipment shall include Controllers, sensors, and controls. Controllers shall serve as an interface between the Central Station and sensors and controls. Data exchange between the Central Station and the Controllers shall include down-line transmission of commands, software, and databases to Controllers. The up-line data exchange from the Controller to the Central Station shall include status data such as intrusion alarms, status reports, and entry-control records. Controllers are classified as alarm-annunciation or entry-control type.

YY. System Response to Alarms: Field device network shall provide a system end-to-end response time of one (1) second or less for every device connected to the system. Alarms shall be annunciated at the Central Station within 1 second of the alarm occurring at a Controller or device controlled by a local Controller, and within 100 ms if the alarm occurs at the Central Station. Alarm and status changes shall be displayed within 100 ms after receipt of data by the Central Station. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five (5) seconds of alarm receipt at the security console. This response time shall be maintained during system heavy load.

ZZ. False Alarm Reduction: The design of Central Station and Controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.

AAA. Error Detection: A cyclic code error detection method shall be used between Controllers and the Central Station, which shall detect single- and double-bit errors, burst errors of eight (8) bits or less, and at least 99 percent of all other multi-bit and burst error conditions. Interactive or product error detection codes alone will not be acceptable. A message shall be in error if one bit is received incorrectly. System shall retransmit messages with detected errors. A two-digit decimal number shall be operator assignable to each communication link representing the number of retransmission attempts. When the number of consecutive retransmission attempts equals the assigned quantity, the Central Station shall print a communication failure alarm message. System shall monitor the frequency of data transmission failure for display and logging.

BBB. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

CCC. Door Hardware Interface: Coordinate with Division 08 Sections that specify door hardware required to be monitored or controlled by the security access system. The Controllers in this Section shall have electrical characteristics which match the signal and power requirements of door hardware. Integrate door hardware specified in Division 08 Sections to function with the controls and PC-based software and hardware in this Section.

1.14 DELIVERY, STORAGE, & HANDLING

A. Central Station, Workstations, and Controllers:

1. Store in temperature and humidity controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 10 to 30 deg C (50 to 85 deg F), and not more than 80 percent relative humidity, non-condensing.

2. Open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.

3. Mark packing list with designations which have been assigned to materials and equipment for recording in the system labeling schedules generated by cable and asset management system specified in Part 2.

4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.15 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 16 to 30 deg C (60 to 85 deg F) and a relative humidity of 20 to 80 percent, non-condensing.

2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 2 to 50 deg C (36 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 1 enclosure.

3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of -18 to 50 deg C (0 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing. NEMA 250, Type 4x enclosures.

4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of -34 to 50 deg C (-30 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 137 km/h (85 mph) and snow cover up to 610 mm (24 in) thick. NEMA 250, Type 4X enclosures.

5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

6. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

7. Security Environment: Use vandal resistant enclosures in high-risk areas where equipment may be subject to damage.

1.16 EQUIPMENT AND MATERIALS

A. General Equipment Requirements: Equipment and materials furnished shall be new, first grade, standard, current products of the manufacturer, and be suitable for the systems being installed and the intent of the design.

1. Where the words, "or shall be an approved equivalent" or like words are used, it shall mean that materials, devices, or equipment of equivalent or equal quality, function, operation, and appearance shall be furnished upon the approval of the Owner. If the contractor recommends equipment substitution, the contractor is responsible for complete documentation of the reason for the change and is financially liable for the design time expended by the security consultant to research the substitution.

2. Any material, device, or equipment damages before or during installation and before acceptance of the completed system, shall be replaced unless repairs can be made that are acceptable to the Owner. Any such replacement or repairs, including repairs to the finish, shall be made at no cost to the Owner.

3. Equipment and materials shall be properly stored, adequately protected, and carefully handled to prevent damage before and during installation. Equipment and materials shall be handled, stored, and protected according to the manufacturers' recommendations. Equipment provided with a factory finish shall be maintained free of dust, dirt, and foreign matter. Dents, marred finishes, and other damage shall be repaired to its original condition or replaced at no additional cost to the Owner.

4. Parts of the project site are finished spaces, including paint, trim, wall covering, floor treatments, lighting, and building mechanical systems. Therefore, the Contractor shall perform the work specified herein, such that, at the completion of his work, all finished space is restored to the original condition existing prior to the commencement of work. During the course of performing the work specified herein, if the Contractor should encounter any damaged finish in any area where the Contractor’s work is to be performed, the Contractor shall notify the Owner in writing prior to performing work in that area. Only after receiving written

confirmation that the existing conditions have been documented and authorization has been given to proceed, shall the Contractor proceed with the work in these areas.

B. Extra Materials

1. Furnish extra materials described below which match products installed and are packaged with protective covering for storage and identified with labels describing contents.

a. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 500 for use.
b. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three (3) units.

1.17 ELECTRICAL POWER

A. Electrical power of 120 Volts Alternating Current (VAC) shall be indicated on the Division 26 drawings. Additional locations requiring primary power required by the security system shall be shown as part of these contract documents. Primary power for the security system shall not be derived from an emergency/back-up power source; therefore the Contractor is responsible for providing battery and UPS back-up power. Alarms shall not be generated as a result of power switching, however, an indication of power switching on (on-line source) shall be provided to the alarm monitor. The Security Contractor shall provide an interface (dry contact closure) between the SMS and the UPS system so the UPS trouble signals and main power fail appear on the SMS operator terminal as alarms.

B. Failure of any on-line battery shall be detected and reported as a fault condition. Battery backed-up power supplies shall be provided sized for eight (8) hours of operation at actual connected load. Requirements for additional power or locations shall be included with the contract to support equipment and systems offered. The following minimum requirements shall be provided for power sources and equipment.

1. UNINTERRUPTIBLE POWER SUPPLY (UPS) ON EMERGENCY POWER

a. The following 120VAC circuits shall be provided by others. The Security Contractor shall coordinate exact locations with the Electrical Contractor:

1.18 ENVIRONMENTAL CONDITIONS

A. Interior, Controlled Environment: All system components except the console equipment installed in interior locations having controlled environments which shall be rated for continuous operation under ambient environmental condition of 0 to 48.9 deg C (32 to 120 deg F) dry bulb and 5 to 100 percent relative humidity, non-condensing.

B. Interior, Uncontrolled Environment: All system components installed in interior locations with uncontrolled environments shall be rated for continuous operation under ambient environmental condition of -17.8 to 48.9 deg C (0 to 120 deg F) dry bulb and 5 to 100 percent relative humidity, non-condensing.

C. Exterior Environment: All system components that are installed in locations exposed to weather shall be rated for continuous operation under ambient environmental conditions of -34 to 48.9 deg C (-30 to 120 deg F) dry bulb and 5 to 100 percent relative humidity, condensing. In addition, the system components shall be rated for continuous operation as specified in UL 294 for outdoor use equipment.

D. Hazardous Environment: All system components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated and installed according to Chapter 5 of the NFPA 70.

E. Console: All console equipment shall, unless noted otherwise, be rated for continuous operation under ambient environmental conditions of 15.6 to 29.4 deg C (60 to 85 deg F) and a relative humidity of 20 to 80 percent.

1.19 LIGHTNING, POWER SURGES, & GROUNDING

A. Transient Voltage Surge Suppression: All cables and conductors extending beyond building façade, except fiber optic cables, which serve as communication, control, or signal lines shall be protected against Transient Voltage surges and have Transient Voltage Surge Suppression (TVSS) protection. The TVSS device shall be UL listed in accordance with Standard TIA 497B installed at each end. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator. Protection shall be furnished at the equipment and additional triple solid state surge protectors rated for the application on each wire line circuit shall be installed within 3'of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode to verify there is no interference.

1. A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

2. An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

3. Maximum series current: 2 AMPS. Provide units manufactured by Advanced Protection Technologies, model # TE/FA 10B or TE/FA 20B.

4. Operating Temperature and Humidity: -40 to 85 deg C (-40 to 185 deg F), 0 to 95 percent relative humidity.

5. Grounding and Surge Suppression

a. The Security Contractor shall provide grounding and surge suppression to stabilize the voltage under normal operating conditions. To ensure the operation of over current devices, such as fuses, circuit breakers, and relays, under ground-fault conditions.
b. Security Contractor shall engineer and provide proper grounding and surge suppression as required by local jurisdiction and prevailing codes and standards referenced in this document.
c. Principal grounding components and features. Include main grounding buses and grounding and bonding connections to service equipment.
d. Details of interconnection with other grounding systems. The lightning protection system shall be provided by the Security Contractor.
e. Locations and sizes of grounding conductors and grounding buses in electrical, data, and communication equipment rooms and closets.
f. AC power receptacles are not to be used as a ground reference point.
g. Any cable that is shielded shall require a ground in accordance with the best practices of the trade and manufactures installation instructions.
h. Protection should be provided at both ends of cabling.

6. See Part 2 for approved TVSS devices.

1.20 COMPONENT ENCLOSURES

A. Construction of Enclosures

1. Consoles, power supply enclosures, detector control and terminal cabinets, control units, wiring gutters, and other component housings, collectively referred to as enclosures, shall be so formed and assembled as to be sturdy and rigid.

2. Thickness of metal in-cast and sheet metal enclosures of all types shall not be less than those in Tables I and II, UL 611. Sheet steel used in fabrication of enclosures shall be not less than 14 gauge. Consoles shall be 16-gauge.

3. Doors and covers shall be flanged. Enclosures shall not have pre-punched knockouts. Where doors are mounted on hinges with exposed pins, the hinges shall be of the tight pin type or the ends of hinge pins shall be tack welded to prevent removal. Doors having a latch edge length of less than 609.6 mm (24 in) shall be provided with a single construction core. Where the latch edge of a hinged door is more than 609.6 mm (24 in) or more in length, the door shall be provided with a three-point latching device with construction core; or alternatively with two, one located near each end.

4. Any ventilator openings in enclosures and cabinets shall conform to the requirements of UL 611. Unless otherwise indicated, sheet metal enclosures shall be designed for wall mounting with tip holes slotted. Mounting holes shall be in positions that remain accessible when all major operating components are in place and the door is open, but shall be in accessible when the door is closed.

5. Covers of pull and junction boxes provided to facilitate initial installation of the system shall be held in place by tamper proof Torx Center post security screws. Stenciled or painted labels shall be affixed to such boxes indicating they contain no connections. These labels shall not indicate the box is part of the Electronic Security System (ESS).

B. Equipment Racks: All vertical equipment racks shall include a forced air-cooling system to be provided by others.

C. Tamper Provisions and Tamper Switches:

1. Enclosures, cabinets, housings, boxes and fittings or every product description having hinged doors or removable covers and which contain circuits, or the integrated security system and its power supplies shall be provided with cover operated, corrosion-resistant tamper switches. In addition, boxes and enclosures in the security closets will be provided with tamper switches.

2. Tamper switches shall be arranged to initiate an alarm signal that will report to the monitoring station when the door or cover is moved. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. It shall take longer than 1 second to depress or defeat the tamper switch after opening or removing the cover. The enclosure and tamper switch shall function together in such a manner as to prohibit direct line of sign to any internal component before the switch activates.

3. Tamper switches shall be inaccessible until the switch is activated. Have mounting hardware concealed so the location of the switch cannot be observed from the exterior of the enclosure. Be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating. Be spring-loaded and held in the closed position by the door or cover and be wired so they break the circuit when the door cover is disturbed. Tamper circuits shall be adjustable type screw sets and shall be adjusted by the contractor to eliminate nuisance alarms associated with incorrectly mounted tamper device shall annunciate prior to the enclosure door opening within 1/4 " tolerance. The tamper device or its components shall not be visible or accessing with common tools to bypass when the enclosure is in the secured mode.

4. All enclosures over 12 square inches shall be hinged with an enclosure lock.

5. Control Enclosures: Maintenance/Safety switches on control enclosures, which must be opened to make routing maintenance adjustments to the system and to service the power supplies, shall be push/pull-set automatic reset type.

6. Provide one (1) enclosure tamper switch for each 24 linear inches of enclosure lock side opening evenly spaced.

7. All security screws shall be Torx-Post Security Screws.

8. The contractor shall provide the owner with two (2) torx-post screwdrivers.

1.21 ELECTRONIC COMPONENTS

A. All electronic components of the system shall be of the solid-state type, mounted on printed circuit boards conforming to UL 796. Boards shall be plug-in, quick-disconnect type. Circuitry shall not be so densely placed as to impede maintenance. All power-dissipating components shall incorporate safety margins of not less than 25 percent with respect to dissipation ratings, maximum voltages, and current-carrying capacity.

1.22 SUBSTITUTE MATERIALS & EQUIPMENT

A. In addition to this Section the Security Contractor shall also reference Section II, Products and associated divisions. Acceptable manufacturers of products included in this specification are indicated in Part 2.0 Products, Acceptable Manufacturers. Manufacturers not listed must be pre-qualified to bid as indicated herein. The Contractor shall list and identify those materials, devices, or equipment for which he intends a substitution. The Owner shall have final authority on the authorization or refusal of substitutions. If there are no proposed substitutions, a statement in writing from the Contractor shall be submitted to the Owner stating same. In the preparation of a list of substitutions, the following information shall be included, as a minimum:

1. Identity of the material or devices specified for which there is a proposed substitution.

2. Description of the segment of the specification where the material or devices are referenced.

3. Identity of the proposed substitute by manufacturer, brand name, catalog or model number and the manufacturer's product name.

4. A technical statement of all operational characteristic expressing equivalence to items to be substituted and comparison, feature-by-feature, between specification requirements and the material or devices called for in the specification; and

5. Price differential.

B. Materials Not Listed: Furnish all necessary hardware, software, programming materials, and supporting equipment required to place the specified major subsystems in full operation. Note that some supporting equipment, materials, and hardware may not be described herein. Depending on the manufacturers selected by the Owner, some equipment, materials and hardware may not be contained in either the Contract Documents or these written specifications, but are required by the manufacturer for complete operation according to the intent of the design and these specifications. In such cases, the Owner shall be given the opportunity to approve the additional equipment, hardware and materials that shall be fully identified in the bid and in the equipment list submittal. The Owner shall be consulted in the event there is any question about which supporting equipment, materials, or hardware is intended to be included.

C. Response to Specification: The Contractor shall submit a point-by-point statement of compliance with each paragraph of the security specification. The statement of compliance shall list each paragraph by number and indicate "COMPLY" opposite the number for each paragraph where the Contractor fully complies with the specification. Where the proposed system cannot meet the requirements of the paragraph, and does not offer an equivalent solution, the offers shall indicate "DOES NOT COMPLY" opposite the paragraph number. Where the proposed system does not comply with the paragraph as written, but the bidder feels it will accomplish the intent of the paragraph in a manner different from that described, the offers shall indicate "COMPARABLE". The offers shall include a statement fully describing the "comparable" method of satisfying the requirement. Where a full and concise description is not provided, the offered system shall be considered as not complying with the specification. Any submission that does not include a point-by-point statement of compliance, as described above, shall be disqualified. Submittals for products shall be in precise order with the product section of the specification. Submittals not in proper sequence will be rejected.

1.23 LIKE ITEMS

A. Where two or more items of equipment performing the same function are required, they shall be exact duplicates produced by one manufacturer. All equipment provided shall be complete, new, and free of any defects.

1.24 WARRANTY

A. The Contractor shall, as a condition precedent to the final payment, execute a written guarantee (warranty) to the Owner certifying all contract requirements have been completed according to the final specifications. Contract drawings and the warranty of all materials and equipment furnished under this contract are to remain in satisfactory operating condition (ordinary wear and tear, abuse and causes beyond his control for this work accepted) for one (1) year from the date the Contactor received written notification of final acceptance from the Owner. All defects or damages due to faulty materials or workmanship shall be repaired or replaced without delay, to the Owner's satisfaction, and at the Contractor's expense. The Contractor shall provide quarterly inspections during the warranty period. The contractor shall provide written documentation to the Owner on conditions and findings of the system and device(s). In addition, the contractor shall provide written documentation of test results and stating what was done to correct any deficiencies. The first inspection shall occur 90 calendar days after the acceptance date. The last inspection shall occur 30 calendar days prior to the end of the warranty. The warranty period shall be extended until the last inspection and associated corrective actions are complete. When equipment and labor covered by the Contractor's warranty, or by a manufacturer's warranty, have been replaced or restored because of it's failure during the warranty period, the warranty period for the replaced or repaired equipment or restored work shall be reinstated for a period equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work. In the event any manufacturer customarily provides a

warranty period greater than one (1) year, the Contractor's warranty shall be for the same duration for that component.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Equipment Rack Equipment

1. Winsted or equivalent

B. Wireline Transmission Media for Electronic Security

1. Black Box

2. Cisco or equivalent

3. GE or International Fiber Systems

C. Miscellaneous Equipment

1. Dell CPU/Monitors or equivalent

2. Spectracom Master Time Clock

3. Pansonic High Definition TV or equivalent

2.2 WIRELINE DATA TRANSMISSION MEDIA FOR SECURITY SYSTEMS

A. General: The Contractor shall configure the wire line data transmission media (DTM) as specified and shown. The DTM shall provide communications between individual pieces of field equipment; and between field equipment and security equipment located at the Security Operations Center located in the Golden Rod Building.

1. Electrical Requirements: The equipment shall operate from a voltage source as shown, plus or minus 10 percent, and 60 Hz, plus or minus 2 percent.

2. Materials and Equipment: All system hardware components shall be produced by manufacturers regularly engaged in the production of wire line communication equipment. Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's name and address, the model, and serial number in a conspicuous place. Equipment located at the security center or a remote control/monitoring station shall be rack mounted as shown. Equipment shall comply with CFR 47 Part 15. Computing devices shall comply with CFR 47 Part 15, Subpart J.

3. Fungus Treatment: System components located in environments conducive to fungus growth shall be completely treated for fungus resistance. Treating materials containing mercury bearing fungicide shall not be used. Treating

materials shall not increase the flammability of the component or surface being treated. Treating materials shall not cause skin irritation or other injury to personnel handling it during fabrication, transportation, operation, maintenance, or during the use of the finished items when used for the purpose intended.

4. Soldering: All soldering shall be done in accordance with standard industry practices.

5. Wire Splices: See Section 280513 (Conductors and Cables for Electronic Security).

6. Enclosures: The Contractor shall provide metallic enclosures as needed for equipment not housed in racks or supplied with a housing. The enclosures shall be as specified or shown.

    a. Interior: Enclosures to house equipment in an interior environment shall meet the requirements of NEMA 250-Type 12.
    b. Exterior: Enclosures to house equipment in an outdoor environment shall meet the requirements of NEMA 250-Type 4. Enclosures exposed to direct sunlight shall be finished with white polyester powder coating and be equipped with a sun shield finished to match the enclosure. Sun shield shall be mounted to protect the top of the enclosure from direct sun and shall extend at least 25.4 mm (1 in) beyond the edges of the enclosure on all sides.
    c. Corrosion-Resistant: Enclosures to house equipment in a corrosive environment shall meet the requirements of NEMA 250-Type 4X.
    d. Hazardous Environment: All system electronics to be used in a hazardous environment shall be housed in a metallic enclosure which meets the requirements of paragraph "Hazardous Environment."
    e. Tamper Provisions: Enclosures, cabinets, housings (other than environmental camera housings), and boxes of every description having hinged doors or removable covers, which contain any part of the DTM or power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved.

        1) Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode; and be wired so they break the circuit when the door or cover is disturbed. Tamper switches on the doors which must be opened to make routine maintenance adjustments to the system and to service the power supplies shall be push/pull-set, automatic reset type.

f. Enclosure Covers: Covers of pull and junction boxes provided to facilitate installation of the system need not be provided with tamper switches if they contain no splices or connections and held in place with tamper proof Torx Center post security screws. Provide stenciled labels for each box.

7. Locks and Key-Lock Operated Switches:

a. All locks required to be installed on system enclosures for maintenance purposes shall be UL listed and approved with manufacturer installed cores or contractor installed construction cores.
b. All keys and locks shall be provided in accordance with Montgomery Community College standards. Contractor shall coordinate key and lock provisions with Germantown campus locksmiths.

8. System Integration: Security System Communication equipment shall be supplied with all adapters, connectors, terminators, cables, card cages, power supplies, rack mounts, and appurtenances as needed for a fully functional system.

B. Equipment: Communications equipment for circuits between the local processor and the central processor unit shall be capable of transmitting data within the error rate specified over the distances shown.

1. Line Drivers: Line drivers shall transmit data at a minimum 9600 bps over the distances as shown.

2. Wire line Cable: Wire line cable shall be insulated solid cooper type conforming to the following specifications. A minimum of No. 22 AWG shall be used for all applications or as specified by manufacturer specifications.

a. Cable Construction: All cable components shall be able to withstand the environment the cable is installed in for a minimum of 20 years.
b. Underground Cable: REA PE-22.
c. Interior Cable: Current issue of the NFPA 70, and EIA TIA.

3. Special Test Equipment: The Contractor shall provide all special test equipment, special hardware, software, tools, and programming or initialization equipment needed to start or maintain any part of the system and its components. Special test equipment is defined as any test equipment not normally used in an electronics maintenance facility.

2.3 NETWORK EQUIPMENT

A. All switches, hubs, and routers shall be provided by the Owner. Contractor shall terminate the NIC and Network Attached Storage (NAS) applicance to the Owner's MC F-Net switch.

B. Owner shall provide PoE ports at MCF-Network switches for Video Surveillance System as shown.

2.4 EQUIPMENT RACKS

A. The equipment rack located in the MDF room shall be furnished by the Owner.

2.5 POWER SURGES AND GROUNDING

A. Transient Voltage Surge Suppression

1. All cables and conductors extending beyond building perimeter shall be protected against Transient Voltage surges and have Transient Voltage surge suppression protection (TVSS) UL listed in accordance with Standard 497B installed at each end. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator. Protection shall be furnished at the equipment and additional triple solid state surge protectors rated for the application on each wire line circuit shall be installed within 915 mm (36 in) of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following waveforms:

    a. A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
    b. An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.
    c. Maximum series current: 2 AMPS. Provide units manufactured by Advanced Protection Technologies, model # TE/FA 10B or TE/FA 20B or approved equivalent.
    d. Operating Temperature and Humidity: -40 to + 85 deg C (-40 to 185 deg F), and 0 to 95 percent relative humidity, non-condensing.

B. Intercom Systems

1. Suppressors shall be installed on the AC power at the point of service and shall meet the following criteria:

    a. UL 1449 Listed
    b. UL 1449 S.V.R. of 400 Volts or lower
    c. Diagnostic Indicator Light(s)
    d. Integrated ground terminating post (where case/chassis ground exists)
    e. Minimum Surge Current Capacity of 13,000 Amps (8 x 20 μSec)
    f. Ten Year Limited Warranty
    g. Acceptable Manufacturer: DITEK CORP., or approved equivalent.

2. Suppressors shall be installed on all telephone/intercom circuits that enter or leave separate buildings and shall meet the following criteria:

    a. UL 497A Listed (where applicable)
    b. UL 497B Listed (horns, strobes, speakers or communication circuits over 300 feet)
    c. Multi Stage protection design

d. Auto-reset over-current protection not to exceed 5 Amps per pair
e. Minimum Surge Current of 1000 Amps per pair (8 x 20 μSec)
f. Ten Year Limited Warranty
g. Acceptable Manufacturer: DITEK CORP., or approved equivalent

1) DTK-SL Series
2) DTK-MT_SCP Series
3) DTK-2MHLP/2MHTP Series
4) DTK-LVLP Series

C. 120 VAC Surge Suppression

1. Shall be Ditek HW Series, or approved equivalent.

2. Continuous Current: Unlimited (parallel connection)

3. Max Surge Current: 13,500 Amps

4. Protection Modes: L - N, L - G, N - G

5. Warranty: Ten Year Limited Warranty

6. Dimension: 73.7 x 41.1 x 52.1 mm (2.90 x 1.62 x 2.05 in)

7. Weight: 2.88 g (0.18 lbs)

8. Housing: ABS

9. Other Specifications:

a. 120HW

1) Agency Approvals: UL1449, cUL
2) Connection: 110-120VAC
3) MCOV: 130VAC
4) Max Surge Current: 22,500A

b. 240HW

1) Agency Approvals: N/A
2) Connection: 120/240VAC
3) MCOV: 130/260VAC
4) Max Surge Current: 27,000A

c. 3W220HW

1) Agency Approvals: N/A
2) Connection: 220-240VAC
3) MCOV: 250VAC
4) Max Surge Current: 13,500A

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 GENERAL

A. The Contractor shall install all system components and appurtenances in accordance with the manufacturer's instructions, ANSI C2, and furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified. Control signals, communications, and data transmission lines grounding shall be installed as necessary to preclude ground loops, noise, and surges from affecting system operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with manufacturers' recommendations and as modified herein.

B. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all schematic system installation/termination/wiring data.

C. All equipment shall be attached to walls and ceiling/floor assemblies and held firmly in place (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

D. Current Site Conditions: The Contractor shall visit the site and verify site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the COTR in a report as defined in paragraph Group II Technical Data Package. The Contractor shall take no corrective action without written permission from the COTR.

PART 4 - SYSTEM PROGRAMMING

4.1 FAMILIARIZATION TRAINING

1. Shall not be provided as a part of this project

4.2 SYSTEM PROGRAMMING

System programming and data entry shall be performed by Owner.

PART 5 - TESTING AND ACCEPTANCE

5.1 PERFORMANCE REQUIREMENTS

A. General:

1. The Contractor shall perform Contractor field, performance verification, and endurance testing and make adjustments to the completed security system when required. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of planned testing shall be given to the Owner at least 60 calendar days prior to the test and after the Contractor has received written approval of the specific test procedures.

2. The Owner shall witness all testing and system adjustments during testing. Written permission shall be obtained from the Owner before proceeding with the next phase of testing. Original copies of all data produced during performance verification and endurance testing shall be turned over to the Owner at the conclusion of each phase of testing and prior to Owner approval of the test.

B. Test Procedures and Reports: The test procedures, shall explain in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. The test reports shall be used to document results of the tests. The reports shall be delivered to the Owner within seven (7) calendar days after completion of each test.

5.2 PRE-DELIVERY TESTING

A. Not Required.

5.3 CONTRACTOR'S FIELD TESTING

A. The Contractor shall calibrate and test all equipment, verify DTM operation, place the integrated system in service, and test the integrated system. Ground rods installed by this Contractor within the base of emergency call box towers shall be tested as specified in IEEE STD 142. The Contractor shall test all security systems and equipment, and provide written proof of a 100% operational system before a date is established for the system acceptance test. Documentation package for CFT shall include completed (fully annotated details of test details) for each device and system tested, and annotated loading sheets documenting complete testing to Montgomery College approval. CFT test documentation package shall conform to submittal requirements outlined in this

Section. The Contractor shall provide the Owner with a written listing of all equipment and software indicating all equipment and components have been tested and passed. The Contractor shall deliver a written report to the Owner stating the installed complete system has been calibrated, tested, and is ready to begin performance verification testing; describing the results of the functional tests, diagnostics, and calibrations; and the report shall also include a copy of the approved acceptance test procedure. Performance verification testing shall not take place until written notice by Contractor is received certifying that a Contractors field test was successful.

5.4 PERFORMANCE VERIFICATION TEST (PVT)

A. The Contractor shall demonstrate the completed ESS complies with the contract requirements. In addition, the Contractor shall provide written certification that the system is 100% operational prior to establishing a date for starting PVT. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The PVT will be stopped and aborted as soon as 10 technical deficiencies are found requiring correction. The Contractor shall be responsible for all travel and lodging expenses incurred for out-of-town personnel required to be present for resumption of the PVT. If the acceptance test is aborted, the re-test will commence from the beginning with a retest of components previously tested and accepted.

B. The PVT, as specified, shall not begin until receipt of written certification that the Contractors Field Testing was successful. This shall include certification of successful completion of testing as specified in paragraph “Contractor’s Field Testing”, and upon successful completion of testing at any time when the system fails to perform as specified. Upon termination of testing by the Owner or Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II.

C. Upon successful completion of the acceptance test, the Contractor shall deliver test reports and other documentation, as specified, to the Owner prior to commencing the endurance test.

D. Additional Components of the PVT shall include:

1. System Inventory

    a. All Device equipment
    b. All Software
    c. All Logon and Passwords
    d. All Cabling System Matrices
    e. All Cable Testing Documents
    f. All System and Cabinet Keys

2. Inspection

a. Contractor shall record an inspection punch list noting all system deficiencies. The contractor shall prepare an inspection punch list format for Owner's approval.
b. As a minimum the punch list shall include a listing of punch list items, punch list item location, description of item problem, date noted, date corrected, and details of how item was corrected.

E. Partial PVT - At the discretion of the Montgomery College project manager, the Performance Verification Test may be performed in part, and should be 100% compliant CFT be performed. In the event that a partial PVT will be performed instead of a complete PVT; the partial PVT shall be performed by testing 10% of the system. The Contractor shall perform a test of each procedure on select devices or equipment.

5.5 ENDURANCE TEST

A. The Contractor shall demonstrate the specified probability of detection and false alarm rate requirements of the completed system. The endurance test shall be conducted in phases as specified below. The endurance test shall not be started until the Owner notifies the Contractor, in writing, that the performance verification test is satisfactorily completed, training as specified has been completed, and correction of all outstanding deficiencies has been satisfactorily completed. Montgomery College shall operate the system 24 hours per day, including weekends and holidays, during Phase I and Phase III endurance testing. Montgomery College will maintain a log of all system deficiencies. The Owner may terminate testing at any time the system fails to perform as specified. Upon termination of testing, the Contractor shall commence an assessment period as described for Phase II. During the last day of the test, the Contractor shall verify the appropriate operation of the system. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Owner prior to acceptance of the system.

1. Phase I (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized in writing by the Owner. If the system experiences no failures, the Contractor may proceed directly to Phase III testing after receiving written permission from the Owner.

2. Phase II (Assessment):

   a. After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Owner. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and recommend the point at which testing should be resumed.
   b. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Owner. The meeting shall not be scheduled earlier than five (5)

business days after the Owner receives the report. As part of this test review meeting, the Contractor shall demonstrate all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Owner will provide a written determine of either the restart date or require Phase I be repeated.

3. Phase III (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized in writing by the Owner.

4. Phase IV (Assessment):

   a. After the conclusion of Phase III, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Owner. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and recommend the point at which testing should be resumed.
   b. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Owner. The meeting shall not be scheduled earlier than five (5) business days after receipt of the report by the Owner. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by repeating appropriate portions for the performance verification test. Based on the review meeting the test should not be scheduled earlier than five (5) business days after the Owner receives the report. As a part of this test review meeting, the Contractor shall demonstrate all failures have been corrected by repeating appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Owner will provide a written determine of either the restart date or require Phase III be repeated. After the conclusion of any re-testing which the Owner may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.

5.6 EXCLUSIONS

A. The Contractor will not be held responsible for failures in system performance resulting from the following:

1. An outage of the main power in excess of the capability of any backup power source provided the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the ESS performed as specified.

2. Failure of an Owner furnished equipment or communications link, provided the failure was not due to Contractor furnished equipment, installation, or software.

3. Failure of existing Owner owned equipment, provided the failure was not due to Contractor furnished equipment, installation, or software.

END OF SECTION 280500

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Refer to 280500 Part 1

1.2 RELATED DOCUMENTS

A. Refer to 280500 Part 1

1.3 RELATED DIVISION PROVISIONS

A. Refer to 280500 Part 1

1.4 REFERENCES

A. Refer to 280500 Part 1

1.5 SUMMARY

A. Section Includes:

1. UTP cabling.
2. 62.5/125-micrometer, multimode optical fiber cabling.
3. Cat6 data cabling
4. RS-232 cabling.
5. RS-485 cabling.
6. Low-voltage control cabling.
7. Control-circuit conductors.
8. Identification products.

1.6 DEFINITIONS

A. Refer to 280500 Part 1

1.7 SUBMITTALS

A. General: Submittal shall be a component of Section 280500 submittal requirements.

B. Qualification Data: For qualified layout technician, installation supervisor, and field inspector. Refer to 280500 Part 1 “Quality Assurance”.

C. Source quality-control reports.

D. Field quality-control reports.

E. Maintenance Data: For wire and cable to include in maintenance manuals.

1.8 COORDINATION

A. Refer to 280500 Part 1

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 300 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.10 MAINTENANCE & SERVICE

A. Refer to 280500 Part 1

1.11 SYSTEM DESCRIPTION

A. The system shall be coordinate with 280500.

1.12 PERFORMANCE REQUIREMENTS

A. Refer to 280500 Part 1

1.13 PROJECT CONDITIONS

1.14 EQUIPMENT AND MATERIALS

A. Refer to 280500 Part 1

1.15 ELECTRICAL POWER

A. Refer to 280500 Part 1

1.16 ENVIRONMENTAL CONDITIONS

A. Refer to 280500 Part 1

1.17 LIGHTNING, POWER SURGES, & GROUNDING

A. Refer to 280500 Part 1

1.18 COMPONENT ENCLOSURES

A. Refer to 280500 Part 1

1.19 ELECTRONIC COMPONENTS

A. Refer to 280500 Part 1

1.20 SUBSTITUTE MATERIALS & EQUIPMENT

A. Refer to 280500 Part 1

1.21 LIKE ITEMS

A. Refer to 280500 Part 1

1.22 WARRANTY

A. Refer to 280500 Part 1

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General: All cabling locations shall be in conduit systems as outlined in Division 26 unless a waiver is granted in writing or an exception is noted on the construction drawings.

B. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.

2. Lacing bars, spools, J-hooks, and D-rings.

3. Straps and other devices.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 x 3 x 2.5 in.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, .75 x 48 x 96 in minimum with actual dimensions to match panel assembly sizing. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry." or meet SI OSHEM specifications. The manufacturer's stamp indicating fire retardant shall not be painted over.

2.3 GENERAL WIRE AND CABLE REQUIREMENTS

A. General: All wire and cable components shall be able to withstand the conditions under which the wire or cable is installed in for a minimum of 20 years without degradation. All wiring shall meet or exceed manufacturers recommended wire specifications and be listed for intended operation. Provide distinct color coding system for all wiring. Each cable shall be numbered at each end with permanent labels.

1. Primary transmission media used for the CCTV System shall be UTP Cat6 cable.

2. The use of Cat6 cable is for cameras and NVR connection to Owner provided Ethernet network.

3. The Contractor shall furnish all wire conductors, cables, interfaces, and connectors as required by the system.

4. Any sensor wire run in wire ducts or troughs where other wiring is present shall be shielded with the shield grounded only at the panel end.

5. All cabling in racks, cabinets and junction boxes shall be neatly strapped, dressed and adequately supported. Cable installation shall conform to good engineering practices and to the standards of the current NFPA 70.

6. In all cases, wire conductors and all cables utilized for the connection of the various components as specified herein, including those components provided by others, shall comply with or exceed the recommendations of the component manufacturers.

7. All wire and cable provided by the Security Contractor shall comply with all applicable codes and ordinances.

8. It shall be the Security Contractor's responsibility to perform all engineering calculations required to ensure the proper cable sizes are provided, so the specified equipment will perform as shown in the manufacturer's specifications. All engineering calculations shall be provided with the prefabrication submittals. It shall be the Security Contractor’s responsibility to obtain and verify the power requirement of NIC, electrified locksets, electrified panic device before carrying out any engineering calculations.

9. Independent of manufacturer's recommendations, cables utilized for signal circuits shall incorporate stranded conductors of not less than 22 AWG. Conductor sizes shall be increased as required to accommodate specific applications and unusual distances.

10. Independent of manufacturer's recommendations, cables utilized for low voltage power circuits shall incorporate stranded conductors of not less than 18 AWG with red and black colored insulation. The red conductor shall be connected as the positive (+) polarity and the black conductor shall be connected as the negative (-) polarity. Conductor sizes shall be increased as required to accommodate specific applications.

B. Specific Requirements:

1. Wire and cable shall be Belden Corporation, Alpha Wire Company, West Penn Wire or equivalent.

2. Wire and cable jacket color shall comply with the facility standard.

2.4 DIGITAL DATA WIRING

A. Cables serving interconnects of digital data between components at the security center or at remote control/monitoring station shall comply with manufacturers requirements and be standard copper wire for each conductor. The hardwire cable shall contain a 100 percent shielding when shielding is specified. Wires with a single overall shield shall have a tinned copper shield drain wire. Shields shall be grounded at the connecting panel end only and in accordance with manufacturer's recommendations.

2.5 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM or CMG.

1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.6 CAT 6 CABLE

A. Premise Horizontal Cable, Gigabit Ethernet, 100BaseTX, 100BaseVG ANYLAN, 155ATM, 622ATM, NTSC/PAL Component or Composite Video, AES/EBU, Digital Video, RS-422

B. Standard Cable:

1. Paired, 4 pairs, twisted, No. 24 AWG, solid bare copper conductors.
2. Unshielded.
3. LSZH - Low Smoke Zero Halogen jacket.

C. Plenum Cable:

1. Paired, 4 pairs, twisted, No. 23 AWG, solid bare copper conductors.
2. FEP - Fluorinated Ethylene Propylene.
3. Unshielded.
4. LSZH - Low Smoke Zero Halogen jacket.

2.7 LOW-VOLTAGE CONTROL CABLE

A. Card Reader Cable: NFPA 70, CM (2 Cables).

1. RS485: 1 pair, twisted shielded, No. 22 AWG, Stranded tinned copper conductors.
2. 12VDC Power: 1 pair, twisted, No 18 AWG, Stranded tinned copper conductors,
3. PVC Insulation.
4. Flame Resistance: Comply with UL 1581.

B. Paired Lock Power Cable: NFPA 70, Type CMG.

1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

C. Plenum-Rated, Paired Lock Power Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.8 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway or conduit complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.9 CABLE IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.
5. EZ Label.
6. Or equivalent.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 GENERAL

A. Wire: The following security provisions apply to systemizing requirements:

1. All security system wiring must be new. All existing wiring not noted for reused and replaced shall be removed.

2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer and compatible with the security system. Number and size and type of conductors shall be as recommended by the security system manufacturer, but not less than 22 AWG twisted shield pair. Network and computer devices may require 24 AWG solid copper conductors for video/data transmission (e.g., TCP/IP, VGA Video) as recommended by the equipment manufacturer.

3. All wire and cable shall be listed and/or approved by a recognized testing agency for intended application and use with a protective signaling system. Provide 300 VAC/60º C rated insulated conductors unless noted otherwise.

4. Wire and cable in air circulation areas which is not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).

5. Wiring used for the multiplex communication loop shall be twisted and shielded and installed in conduit unless specifically accepted by the security equipment manufacturer.

6. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring, a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

B. Method of Wiring

1. General: Wire each alarm, trouble, and supervisory signal, initiating circuit, communication circuit, and each security notifying appliance circuit for supervised operation.

2. Wiring within Cabinets: Provide wiring within cabinets installed parallel with or at right angles to the sides and back of the enclosure. All conductors which are terminated, spliced, or otherwise interrupted in any enclosure associated with the security system shall be connected to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with either crimp-on terminal spade lugs or approved pressure type terminal blocks.

Terminal blocks shall be secured in each junction box to the junction box cover plate.

3. Interior Work: Cables installed in plenums shall meet UL 910, and cables to be installed in risers shall meet UL 1666.

4. Installation in Ducts or Conduits: A cable lubricant compatible with the cable sheathing material shall be used on all cables pulled. Pulling fixtures shall be attached to the cable strength members. If indirect attachments are used, the grip diameter and length shall be matched to the cable diameter and characteristics. If indirect attachment is used on cables having only central strength members, the pulling forces shall be reduced to ensure the fibers are not damaged from forces being transmitted to the strength member. During pulling the cable pull line tension shall be continuously monitored and not exceed the maximum tension as given by the cable manufacturer. The mechanical stress placed upon a cable during installation shall not twist or stretch the cable.

   a. A cable feeder guide shall be used between the cable reel and the face of the duct or conduit to protect the cable and guide it into the duct or conduit as it is played off the reel. As the cable is played off the reel, it shall be carefully inspected for jacket defects. Precautions shall be taken during installation to prevent the cable from being kinked or crushed and the minimum bend radius of the cable is not exceeded at any time. Cable shall be hand fed and guided through each manhole and additional lubricant shall be applied at all intermediate manholes.
   b. When practicable, the center pulling techniques shall be used to lower pulling tension. That is, the cable shall be pulled from the center point of the cable run towards the end termination points. The method may require the cable to be pulled in successive pulls. If the cable is pulled out of a junction box or manhole the cable shall be protected from dirt and moisture by laying the cable on a ground covering.

5. Vertically Run Cable: When possible, use gravity to assist in cable pulling; pull cable from top of run to bottom of run. Hand-pull cables if possible; if machine assistance is required, monitor tension and do not exceed the specific cable tension limits. After installation, the vertical tension on the cable shall be relieved at maximum intervals of 30.48 m (100 ft) using a split support grip.

6. Cable Taps: The Contractor shall provide a terminal cabinet where any circuit tap is made.

7. Color Coding: The Contractor shall distinctively color code all wiring differently from the normal building wiring. Identify conductors by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Wire the alarm initiating and notification signal devices so removal will cause the system trouble device to sound. Each conductor used for the same specific function shall be distinctively color coded. Use two (2) different color codes for each interior alarm circuit; one

(1) for each loop. Each circuit color code wire shall remain uniform throughout the circuit.

8. Termination: End-of-line supervisory resistors or devices are to be provided at the sensor device location. The end of line resistor network shall be per manufacturer's recommendations; in the absence of such, it shall consist of two (2) 1k resistors, one (1) across the normally closed contact of the device and the other in series with the normally closed circuit. See drawing details for further information. Use of GRI Resistor Packs is preferred.

9. No "stick-on" cable ties shall be used within the enclosure.

C. Cable Installation

1. All field wiring required for interconnection of the various security system components shall be installed within conduit.

2. All circuits shall be protected to avoid interruption of service due to short-circuiting or other conditions which may adversely affect the connecting devices. Each individual signaling circuit shall be classified as a circuit pair.

3. Screw terminal blocks or connectors shall be furnished for all cables which interface with racks, cabinets, consoles or equipment modules. No more than 2 mm of exposed bare wire may show when either crimped or fastened to a connector block or terminal strip.

4. Every cable or wire shall be permanently labeled at each end. Marking labels used on cables shall correspond to labels shown on as-built drawings and matrix sheets. Utilize a cable administration and labeling solution compliant TIA/EIA-606-A, such as Panduit TIA/EIA-606-A compliant Cable Identification and Labeling System. Wire cable numbers cannot repeat anywhere on the project. Each terminal of each field terminal strip shall be permanently labeled to show the zone, instrument or item served. Terminal blocks shall be numbered by circuit pairs, such as 1 to 25, 26 to 50, etc.

5. Care shall be exercised in wiring to avoid damage to the cables or the equipment. All joints and connections shall be made with mechanical butt splice connectors. The crimping tool used shall be recommended by the manufacturer. Wire nuts shall not be an acceptable splice method.

6. To reduce the possibility of signal contamination, all cables shall be grouped according to the signals being carried. The horizontal and vertical cable runs should be bundled or grouped as follows:

   a. Low Voltage Power
   b. Signal, Control Cables, and Video Cables

7. All cabling shall be U.L. listed for its intended application and meet or exceed the standards as recommended by the manufacturers of the components being interconnected. All shielded cabling used shall be 100 percent shielded.

8. All system wiring shall be installed in accordance with the instructions provided by the manufacturers of the components being used in the system and in accordance with codes, specifications, and standards as referenced herein.

9. Splices shall not be permitted in system wiring between components which are incorporated in the system. Wiring runs must terminate at either a system component or a junction box where wiring is interconnected using terminal strips or connectors. Wire ends shall be prepared for attachment to component terminals in accordance with the recommendations of the equipment manufacturers. If there is no alternative and a wire/cable splice must be made, the Contractor shall notify the Owner and request approval through a formal RFI process prior to making the wire splice.

    a. The RFI shall include the following:

        1) The Contractor shall identify the device and/or system affected by the proposed splice and why the splice is required.
        2) Provide in detail the methodology which shall be utilized for the wire/cable splice. A diagram may be used to demonstrate methodology but shall not replace the written methodology requirement.
        3) If splicing is required for more than five (5) wires/cables, a formal wire management plan shall be developed to provide methodology for maintaining wire/cable consistency and performance.
        4) In all instances the Contractor shall provide the Owner with a mock-up of the proposed splice and samples of the materials to be used.
        5) The Contractor shall not proceed until written approval has been received from the Owner for the splice and the splice materials.

    b. The following criteria shall be utilized for installing wire/ cable splices.

        1) Twist type connectors shall not be used for wire splicing.
        2) Wire splices shall be made on binding screw captive mechanical compression terminal strips.
        3) Soldered and crimped connections are allowed and shall be accomplished with crimping Lug Manufacturers Calibrated Tool.
        4) Solder connections shall be applied in accordance with BICSI standards.
        5) Mechanical splices shall utilize a UL listed ratchet type connector. The Contractor shall select the appropriate connector size based on gauge of the wire/cable being spliced. The Contractor shall only use manufacture approved full cycle ratchet crimping devices.
        6) The Contractor shall utilize appropriately sized UL listed heat shrink tubing. Splices shall be encapsulated with an epoxy or ultraviolet

light cured splice encapsulator, particularly if the spliced wire/cable is direct-buried, environmentally exposed, or located in an exterior hand hold.

7) The Contractor shall ensure all completed splices are accessible. Splices shall be made in lockable/tampered security enclosures or in security junction/pull boxes that use tamper proof Torx Center post security screws to secure the box cover. At no time shall spliced wires/cables be permitted to be pulled into the conduit system.
8) For all splices, the Contractor shall affix a permanent label (self-adhesive or heat shrink type) to the wire/cable adjacent to the splice. The label shall indicate the device or circuit the wire/cable originates at. The label shall be identical to the labels found at either terminated end of the wire/cable.
9) All spliced wires/cables shall be tested in witness of the COTR to ensure system performance is not adversely affected by the splices' presence.

c. All copper conductor splices shall be accomplished in the following method:

1) Strip insulation from wires to be spliced using caution not to score or strip away the actual conductor.
2) Twist together the stripped conductors for a minimum of four rotations.
3) Solder the twisted conductors using rosin core solder.
4) Trim the twisted and soldered conductors to a length accommodated by the vinyl insulated closed end splice or butt splices in the next step. Trimmed bare conductors shall not extend beyond the insulated closed end splice (or equal).
5) Crimp insulated closed end splice utilizing a full cycle ratchet crimp tool approved by the splice manufacturer. The crimped connections shall be free of any movement between the wire and crimp splice device.

10. Connections at devices shall be soldered or fastened with approved crimp connectors. No wire nuts will be permitted. Wire should be twisted four times before a crimp connector is applied. The Manufacturers crimping tool shall be utilized for the crimp connectors of choice. Environmental connectors shall be used in harsh or outdoor environments. Devices requiring connections within metal extrusions associated with perimeter windows and doors are considered to be a harsh environment.

11. All mounted wire ties shall be the screw down type. Wire ties utilizing only an adhesive back are not acceptable.

12. Heat shrink tubing must be installed on all cable ends within cabinets.

13. Cable shields are to be grounded only at the DGP end, for alarms and CCTV. Shields are to be carefully insulated to prevent conductor shorts.

14. Permanent labels, attached to each cable end, shall be close to cable ends in cabinets and not hidden from view by cable ties. Labels must be visible without having to cut cable ties to read the number.

D. Grounding Practices

1. The existing single system ground point shall be maintained for all security and security related systems described in the BICSI guidelines and is to be provided and installed by the Contractor.

2. Under no circumstances shall either the conduit or AC neutral be used for the security system ground reference point.

E. Control of Electromagnetic Interference (EMI)

1. The control of EMI is critical to the reliable operations of the systems described in these specifications. It is the responsibility of the Security Contractor to ensure all equipment and systems proposed meet FCC requirements and certifications for type regarding electromagnetic emissions. The Security Contractor shall submit evidence of such certifications with their pre-fabrication submittals.

2. All equipment shall be installed in accordance with manufacturers' specifications and recommendations to assure compliance with FCC certifications and requirements. This shall include proper installation to maintain case integrity; proper fastening of conductors, wires, cables, and connectors; use of appropriate connectors and fasteners; and following manufacturers' recommendations for grounding practices.

3. The Security Contractor shall certify compliance with manufacturers' recommendations and specifications regarding control of EMI.

3.2 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of the room where multiple sheets of plywood are installed around perimeter walls of room.

2. Install cable trays to route cables if conduits cannot be located in these positions.

3. Secure conduits to backboard when entering room from overhead.

4. Extend conduits 75 mm (3 in) above finished floor (AFF).

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 2440 mm (96 in) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

5. Cables may not be spliced. Secure and support cables at intervals not exceeding 760 mm (30 in) and not more than 150 mm (6 in) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable". Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 200 mm (8 in) above ceilings by cable supports not more than 1525 mm (60 in) apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable 1830 mm (72 in) long shall be neatly coiled not less than 300 mm (12 in) in diameter below each feed point.

E. Separation from EMI Sources

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 127 mm (5 in).
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 300 mm (12 in).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 600 mm (24 in).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2.5 in.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 in.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 in.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 75 mm (3 in).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 150 mm (6 in).

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 1200 mm (48 in).

6. Separation between Cables and Fluorescent Fixtures: A minimum of 127 mm (5 in).

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.

2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.

3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.5 CONNECTIONS

A. Comply with requirements in Division 28 Section "Access Control" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 CABLE IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 WIRELINE DATA TRANSMISSION

A. Installation: The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2 and as shown, and furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable data transmission system.

B. Identification and Labeling: The Contractor shall supply permanent identification labels for each cable at each end that will appear on the as-built system loading sheets. The labeling format shall be identified and a complete record shall be provided to the COTR with the final documentation. Each cable shall be identified by type or signal being carried and the termination points. The labels shall be printed on letter size label

sheets that are self laminated vinyl which can be printed from a computer data base or spread sheet. The labels shall be E-Z code WES12112 or equivalent. Contractor shall create a unique cable identification system where no two cables will have the same identification label.

C. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.

D. Identification and Labeling: The Contractor shall supply identification tags or labels for each cable. Cables shall be labeled at both end points and at intermediate hand holes, manholes, and junction boxes. The labeling format shall be identified and a complete record shall be provided to the COTR with the final documentation. Each cable shall be identified with type of signal being carried and termination points.

PART 4 - TESTING AND ACCEPTANCE

4.1 TESTING

A. Wire Line Test: The Contractor shall test each wireline pair. The Contractor shall prepare reports containing test results and certify in the reports conformance to the following requirements:

1. Attenuation: Measurements shall be made with test tone of 1,004 Hz at 0dBm. Attenuation distortion not to exceed minus three (-3) dB to 12 dB from 300 to 3,000 Hz, and minus two (-2) dB to eight (8) dB from 500 to 2,500 Hz referenced to the attenuation of the 1,004 Hz test tone. Attenuation at 1,004 Hz of less than 40 dB.

2. Envelope Delay: Envelope delay distortion no greater than 1,750 microseconds over a range of 800 to 2,600 Hz.

3. Insulation Resistance: Insulation resistance wire to wire of wireline pair of at least 10,000 megohm-miles measured at 24 deg C (72 deg F).

4. Loop Resistance: Loop resistance of less than 1,000 ohms with end of line resistance > 50 ohms.

B. Cat 6 cable field test requirements

1. Every cabling link in the installation shall be tested for:

   a. Wire Map
   b. Length
   c. Insertion Loss
   d. NEXT Loss
   e. PS NEXT Loss

f. ACR-F Loss
g. PS ACR-F Loss
h. Return Loss
i. Propagation Delay
j. Delay Skew

2. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "Permanent Link" performance specification as defined in the Category 6 Standard.

3. One hundred percent of the installed cabling links must pass the requirements of the Category 6 Standard mentioned in A.1 above and as further detailed in Section B. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section C below.

4. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BiCSi or the ACP (Association of Cabling Professionals).

5. The test equipment (tester) shall comply with the accuracy requirements for level III field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 3 of ANSI/TIA-1152 (Table 3 in this TIA document also specifies the accuracy requirements for the Channel configuration).

6. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.

7. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

8. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

9. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.

10. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent '*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

11. Test Result Documentation

    a. The test results/measurements shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test and that these results cannot be modified at a later time.
    b. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.
    c. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information

        1) The identification of the link in accordance with the naming convention defined in the overall system documentation
        2) The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number
        3) The date and time the test results were saved in the memory of the tester.

    d. General Information to be provided in the electronic data base with the test results information for each link:

        1) The identification of the customer site as specified by the end-user
        2) The identification of the link in accordance with the naming convention defined in the overall system documentation
        3) The overall Pass/Fail evaluation of the link-under-test
        4) The name of the test limit selected to execute the stored test results
        5) The cable type and the value of NVP used for length calculations
        6) The date and time the test results were saved in the memory of the tester
        7) The brand name, model and serial number of the tester
        8) The identification of the tester interface

9) The revision of the tester software and the revision of the test limits database in the tester
10) The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5.

e. The detailed test results data to be provided in the electronic database for must contain the following information:

12. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.

a. Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1) and the test limit value
b. Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value
c. Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value
d. Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair
e. Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link
f. NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link
g. PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link

C. Contractor's Field Test: The Contractor shall verify the complete operation of the data transmission system during the Contractor's Field Testing. Field test shall include a bit error rate test. The Contractor shall perform the test by sending a minimum of 1,000,000 bits of data on each DTM circuit and measuring the bit error rate. The bit error rate shall not be greater than 1 bit out of each 100,000 bits sent for each dial-up DTM circuit, and 1 bit out of 1,000,000 bits sent for each leased or private DTM circuit. The Contractor shall submit a report containing results of the field test.

D. Acceptance Test and Endurance Test: The wire line data transmission system shall be tested as part of the completed IDS and EECS during the Acceptance test and Endurance Test as specified.

END OF SECTION 280513

SECTION 280810 SECURITY SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment Start-Up and Functional Performance Testing.

B. Validation of proper and thorough installation of Division 28 (Security) systems and equipment.

C. Generic Start-Up Documentation for electrical systems and equipment.

D. Development of final testing Documentation for telecommunication systems and equipment.

E. System Start-Up and Turn-Over procedures.

F. Coordination and execution of Training Events.

1.2 GENERAL DESCRIPTION

A. Commissioning (Commissioning) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.

C. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

D. This Section outlines the Cx procedures specific to the Division 28 Contractors. Requirements common to all Sections are specified in Sections n 019113 and 019114 This Section and other sections of the specification details the Contractor's responsibilities relative to the Cx process.

1.3 SCOPE

A. The following systems and equipment are included in the Scope of Commissioning for this project:

1. Access Control
2. CCTV/Surveillance
3. Emergency Call System

1.4 RELATED WORK AND DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. The Cx process references many related Sections, particularly Section 019113 - General Commissioning. It is important for all Contractors subject to the Cx process to be familiar with Section 019113.

C. Refer to Section 019113 for a complete list of Sections on Related Work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113 for a complete list of Definitions and Abbreviations.

1.6 REFERENCE STANDARDS

A. Local Building Codes

B. National Fire Protection Association (NFPA)

C. National Electric Code (NEC)

D. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

E. Institute of Electrical and Electronics Engineers (IEEE)

F. Underwriters Laboratory, Inc. (UL)

1.7 DOCUMENTATION

A. Documentation shall be as required in Section 019113. In addition, Contractor shall also provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format.
2. Field Testing Agency Reports: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports shall be provided in PDF electronic format.

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 28.

B. Construction Phase

1. Coordinate the checkout of the fire alarm system and the approval of the regulatory authorities with the Cx process.

1.9 TRAINING

A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. Unless otherwise noted, all equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.

B. Testing Instrumentation: Contractor shall provide all instrumentation necessary for tests for which they are responsible. CA will provide standard instrumentation for measuring medium and low voltage electrical voltage and current. CA will provide receptacle testers for normal and GFI receptacle tests. Contractor shall provide all other instrumentation required to accomplish the specified testing,

2.2 ACCESS DEVICES

A. Contractor shall provide all access devices necessary to support functional testing.

2.3 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 and the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines 'generic' or minimally acceptable Start-Up Documentation (which are defined to include both 'Start-Up Checks' and 'Start-Up Tests') and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

B. Section 019113 defines the systems and equipment Start-Up process in detail and provides definitions for Start-Up Documentation, including the generic Start-Up Documentation provided below.

3.2 START-UP CHECKS COMMON TO ALL SYSTEMS

A. The following Start-Up verifications and procedures shall be considered common to all systems:

1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
2. Verify labeling is affixed per specification and visible.
3. Verify prerequisite procedures are done.
4. Inspect for damage and ensure none is present.
5. Verify system is installed per the manufacturer's recommendations.
6. Verify system has been tested per manufacturer's recommendations.
7. Verify that access is provided for inspection, operation and repair.
8. Verify that access is provided for eventual replacement of the equipment.
9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
10. Verify all gages and test ports are provided as required by contract documents and manufacturer's recommendations
11. Verify all recorded nameplate data is accurate.
12. Verify that the installation ensures safe operation and maintenance.
13. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
14. Verify all monitoring and ensure all alarms are active and set per Owner's requirements.

3.3 SECURITY MANAGEMENT SYSTEM

A. General: Provide the services of a manufacturer's certified specialist to supervise the installation, make adjustments, and perform tests on the Security system and train Owner's maintenance personnel.

B. Start-up checklists: Perform the following final checks before startup

1. Ensure all labeling is affixed and accurate
2. Ensure all terminations are tight.
3. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
4. Review that all field input and output devices as shown on the construction drawings and shop drawings are installed.
5. Check wire supervision on all devices.
6. Visual inspection of all wiring.
7. Ensure all central CPU's, peripherals, and all panel control functions are installed and operating.
8. Spot check installation and device placement for conformance with the design documents
9. Verify equipment is properly installed and mounted in consoles and racks.

C. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Test all central CPU's, peripherals, and all panel control functions.
2. Test all electrical supervision of all input and output sensor and data Communication bus circuits.
3. Test of battery and battery chargers.
4. Verify battery alarm circuitry.
5. Verify that correct field device is that shown on monitor.
6. Verification of required systems response time.
7. Verify system response on loss of facility power and start up of the emergency generator.
8. For enunciator panels, validate correct graphic and correct identification of all zones. Test the action and interlocks of all override switches as appropriate
9. For Operator Interfaces:

a. Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
b. Output all specified reports for review and approval.
c. Verify the alarm printing and logging is functional and per requirements

10. Validate all interfaces with other systems on a point by point basis
11. Demonstrate software and programming functions of all microprocessor systems.

3.4 ACCESS CONTROL SYSTEM

A. General: Provide the services of a manufacturer's certified specialist to supervise the installation, make adjustments, and perform tests on the Access Control System and train Owner's maintenance personnel.

B. Start-up checklists: Perform the following final checks before startup

1. Ensure all labeling is affixed and accurate
2. Ensure all terminations are tight.
3. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
4. Review that all field input and output devices as shown on the construction drawings and shop drawings are installed.
5. Check wire supervision on all devices.
6. Verification of hardwired door interlocking where required.

C. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Check location of all readers, biometric devices (iris and fingerprint) and switches to ensure conformance with requirements.
2. Cause activation of all devices, assure alarms and/or control sequences are initiated and resulting response is per the requirements.
3. Issue three access cards with varying access levels and spot check access devices (card readers). One of the access cards shall be assigned total access. One moderate access and the third minimal. Ensure that access is granted/denied appropriately. Ensure record of entry is received appropriately.
4. Verify breech signal is received for a sample of doors with door contacts.
5. Verify interfaces with all other inter-related systems.
6. Validate all interfaces with other systems on a point by point basis

3.5 CCTV SYSTEM

A. General: Provide the services of a manufacturer's certified specialist to supervise the installation, make adjustments, and perform tests on the CCTV system and train Owner's maintenance personnel.

B. Start-up checklists: Perform the following final checks before startup

1. Ensure all labeling is affixed and accurate
2. Ensure all terminations are tight.
3. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
4. Review that all field cameras input and output devices are as shown on the construction drawings and shop drawings are installed.
5. Check wire supervision on all devices.

C. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Check location of all cameras to ensure conformance with requirements.
2. Spot check video signals from CCTV cameras. Validate that signal is strong and clear.
3. Verify operation of camera pan, zoom and tilt operations and also that full scope of defined area are captured.
4. Test of all video surveillance system components, cameras, switchers, and monitors (including automatic switching of the CCTV system with appropriate intercom call).
5. Verify interfaces with all other inter-related systems.
6. For monitors, validate proper switching and display of all zones.
7. Validate all interfaces with other systems on a point by point basis

D. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

1. Review data in Operating and Maintenance Manuals.

3.6 ROOM/ZONE CHECKOUT

A. Contractor shall complete a checklist acknowledging completion of Div. 28 responsibilities for all rooms. Checklist shall include items such as the following as applicable:

B. Typical Room:

1. All faceplates and covers on, clean, labeled, and all checked
2. Cameras in place and acceptable travel and coverage checked.
3. All locking devices functional and operate against room pressure.

3.7 EMERGENCY CALL SYSTEM

A. General: Provide the services of a manufacturer’s certified specialist to supervise the installation, make adjustments, and perform tests on the Emergency Call System and train Owner's maintenance personnel.

B. Start-up checklists: Perform the following final checks before startup

1. Ensure all labeling is affixed and accurate
2. Ensure all terminations are tight.
3. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
4. Check wire supervision on all devices.

C. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Check location of all call stations to ensure conformance with requirements.
2. Check audio signals from the call stations. Validate that signal is strong and clear.
3. Verify operation of the Strobe.
4. Verify interfaces with all other inter-related systems.
5. Validate all interfaces with other systems on a point by point basis

D. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

E. Review data in Operating and Maintenance Manuals.

END OF SECTION 280810

SECTION 280820 – FIRE ALARM SYSTEM COMMISSIONOING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment testing and start-up

B. Validation of proper and thorough installation of Fire Alarm systems and equipment

C. Equipment performance verification

D. Functional testing of Fire Protection systems

E. Documentation of tests, procedures, and installations

F. Coordination of training

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) is retained by the Owner shall work with the Contractor and the Design Engineer to direct and oversee the Cx process and perform functional performance testing.

C. This Section outlines the Cx procedures specific to the Fire Alarm Contractors. Requirements common to all Sections are specified in Sections 019113 and 019114 and the Cx Plan.

1.3 SCOPE

A. The following are included in the Scope of Commissioning on this project:

1. Fire Alarm and Detection Systems

1.4 RELATED WORK AND DOCUMENTS

A. Commissioning Plan: The Commissioning Plan outlines the commissioning process beyond the construction specification. All Contractor responsibilities are outlined in Specifications. Cx Plan is available to the Contractor to understand the context of their responsibilities but does not define any additional responsibilities of the Contractor

B. Section 019113 – General Commissioning Requirements: details the Cx requirements common across all divisions

C. Section 019114 – Functional Testing Procedures: Outlines the generic functional testing procedures required.

D. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

E. Section 210800– Fire Suppression Systems Commissioning: Details the commissioning procedures specific to Division 21 work.

F. Section 220800– Plumbing Systems Commissioning: Details the commissioning procedures specific to Plumbing Systems (Div 22) work.

G. Section 230800 – HVAC Systems Commissioning: Details the commissioning procedures specific to HVAC (Div 23) work.

H. Section 230995 – Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.

I. Section 260800 – Electrical Systems Commissioning: Details the commissioning procedures specific to Division 26 work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113

1.6 REFERENCE STANDARDS

A. Local Building Codes

B. National Fire Protection Association (NFPA)

C. National Electric Code (NEC)

D. American Society for Testing and Materials (ASTM)

E. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

F. Illuminating Engineering Society (IES)

G. Institute of Electrical and Electronics Engineers (IEEE)

H. International Electrical Testing Association (NETA)

I. National Electrical Manufacturer Association (NEMA)

J. Underwriters Laboratory, Inc. (UL)

1.7 DOCUMENTATION

A. In addition to the documentation required in Section 019113, Contractor shall provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format. These may include but are not limited to:

a. Fire alarm system approval and certifications

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to the Fire Alarm System.

B. Construction Phase

1. Coordinate the checkout of the fire alarm system and the approval of the regulatory authorities with the Cx process.

1.9 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified.

2.2 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 START-UP PROCEDURES - GENERAL

A. Part 3 of this Section outlines specific start-up, check out and training requirements for systems and equipment. These requirements along with those specified in the individual section provide a minimum or guideline for development of start-up procedures, checklists and tests. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized Start-Up Procedures specific to the equipment and systems installed on this project.

B. Coordination with other contractors. Fire Alarm contractor shall coordinate with the mechanical contractors for testing of mechanical components, fire suppression contractor for checkout of alarming of the suppression systems and electrical contractor for testing of electrical components.

3.2 FIRE ALARM EQUIPMENT / FIRE ALARM DETECTION SYSTEM

A. General: Provide the services of a qualified fire alarm specialist to supervise the installation, make adjustments, and perform tests on the fire alarm system and train Owner's maintenance personnel.

B. Start-Up Checks: Perform the following final checks before startup

1. Ensure all labeling is affixed and accurate
2. Ensure all terminations are tight.
3. Ensure adequate access is provided to all panels and that documentation of that panel is provided in it.
4. Review that all fire alarm devices are installed as shown on the construction and record drawings.
5. Review height and locations of pull stations and visual alarms to comply with ADA.
6. Review that smoke and duct detectors are installed according to NFPA 72E and local codes
7. Check that fire alarm system control panel is clear with no trouble or ground faults.
8. Sprinkler flow and tamper switches have been adjusted
9. Check wire supervision on all devices.

C. Starting Procedures: Follow the manufacturer's written procedures and the following as a minimum:

1. Check location of all sensors and switches to ensure conformance with requirements. Validate the record drawings reflect the actual installation. Revise record drawings as required to match installed conditions
2. Cause activation of all devices, assure alarms are initiated and resulting response is per the requirements.

    a. Document all actions and responses in a start up checklist. Submit checklist along with record drawings along with the request for local authority witness/certification.

3. Verify interfaces with all other inter-related systems or equipment including FMS, sound systems, security systems, HVAC systems, vertical delivery systems, etc. on a point by point basis for all points
4. Validate all output devices (speakers and strobes) meet the code criteria (96 dBa at 10’ and 117 candela at peak)
5. Activate high temperature detectors in the elevator machine room. Verify all sequences including elevator shunt off, elevator recall including alternate floors when main floor is in alarm.

6. Activate all sprinkler flow switches. Validate that appropriate zone enunciates and alarms sound.
7. Verify audio aspects of the system function as required. Verify paging messages can be heard throughout the building.
8. For annunciator panels, validate correct graphic and correct identification of all zones. Test the action and interlocks of all override switches as appropriate
9. For Operator Interfaces:

    a. Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
    b. Output all specified reports for review and approval.
    c. Verify the alarm printing and logging is functional and per requirements

10. Validate all interfaces with other systems on a point by point basis
11. Obtain written approval from the Authority Having Jurisdiction (AHJ).

D. Demonstration/Certification Procedures:

1. After the system has been fully started and checked out and all record drawings are revised to match actual conditions, submit a request for local authority approval/certification at least two weeks in advance of the proposed date.
2. Follow local authority Process to request the certification which includes submitting record drawings and system checkout documentation.
3. Demonstrate actuation of every device (pull switches, smoke detectors, heat detectors, flow switches, etc.) and resulting sequence to local authority representative during the certification.
4. Demonstrate all communications capabilities.

E. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

1. Review data in Operating and Maintenance Manuals.

END OF SECTION 280820

SECTION 281300 - ACCESS CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Refer to 280500 Part 1

1.2 RELATED DOCUMENTS

A. Refer to 280500 Part 1

1.3 RELATED DIVISION PROVISIONS

A. Refer to 280500 Part 1

1.4 REFERENCES

A. Refer to 280500 Part 1

1.5 SUMMARY

A. This Section includes access control devices to be connected to the Security Management System (SMS).

1. Access Control:

a. Regulating access through doors, gates, traffic-control bollards and others access controls as specified in drawing documents.
b. Anti-passback where required.
c. Surge and tamper protection.
d. Secondary alarm annunciator.
e. Card readers.
f. Biometric identity verification equipment.
g. Push-button switches.
h. RS-232 ASCII interface.
i. Reporting.

1.6 DEFINITIONS

A. Refer to 280500 Part 1

1.7 SUBMITTALS

A. Refer to 280500 Part 1

1.8 COORDINATION

A. Refer to 280500 Part 1

1.9 QUALITY ASSURANCE

A. Refer to 280500 Part 1

1.10 MAINTENANCE & SERVICE

A. Refer to 280500 Part 1

1.11 SYSTEM DESCRIPTION

A. Refer to 280500 Part 1

1.12 PERFORMANCE REQUIREMENTS

A. Refer to 280500 Part 1

1.13 DELIVERY HANDLING & STORAGE

A. Refer to 280500 Part 1

1.14 PROJECT CONDITIONS

A. Refer to 280500 Part 1

1.15 EQUIPMENT AND MATERIALS

A. Refer to 280500 Part 1

1.16 ELECTRICAL POWER

A. Refer to 280500 Part 1

1.17 ENVIRONMENTAL CONDITIONS

A. Refer to 280500 Part 1

1.18 LIGHTNING, POWER SURGES, & GROUNDING

A. Refer to 280500 Part 1

1.19 COMPONENT ENCLOSURES

A. Refer to 280500 Part 1

1.20 ELECTRONIC COMPONENTS

A. Refer to 280500 Part 1

1.21 SUBSTITUTE MATERIALS & EQUIPMENT

A. Refer to 280500 Part 1

1.22 LIKE ITEMS

A. Refer to 280500 Part 1

1.23 WARRANTY

A. Refer to 280500 Part 1

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Security Management System Software

1. GE Security Facility Commander

B. Security Management System Field Hardware

1. GE Security ACULX16 Network Intelligent Controller – No Exception

2. GE Security Remote Reader Electronics – No Exception

C. Card Reader

1. HID Thin Line II Proximity Card Reader – No Exception

2. HID Mini Prox Reader

2.2 FACILLITY COMMANDER SECURITY MANAGEMENT PLATFORM SYSTEM REQUIREMENTS

A. Architecture:

1. The ISMS shall be a scalable Microsoft Windows based client/server application for deployment of integrated security operations to include system configuration management & administration, command & control, and real-time monitoring for access control, alarm management, video surveillance, photo ID credentialing, and interfacing with secondary security subsystems and business database applications.

2. The ISMS application shall be a true 32bit multi-threaded code set developed in a high level "C" language; supported on Microsoft Windows XP, Vista, Server 2003, and Server 2008 Operating Systems on 32bit or 64bit server deployments.

3. The ISMS database shall be supported on Microsoft SQL Sever 2005 and SQL Sever 2008 on 32bit or 64bit server deployments.

4. The ISMS deployment shall allow but not require, the separation of database server, file server, and application server roles to provide maximum flexibility and conformance with IT data center deployment practices.

5. The ISMS shall support user definable record-level database partitioning, for defining limited views of the ISMS database.

6. The ISMS database shall support open direct database connectivity for importing cardholder and card ID data from external systems and/or database applications. The ISMS shall facilitate interfacing by providing the following capabilities:

    a. Real time and batch processing of data via ODBC, JDBC or OLE DB over a network connection.
    b. Insert, update, and delete record information.
    c. Automatic download of data to ISMS control panels based on database changes.
    d. Provide audit trail in the operator history/archive database for all database changes initiated by the interface.

7. The ISMS database shall support operating in a Microsoft SQL Server Cluster where the ISMS application server(s) support a shared database cluster.

8. The ISMS shall be capable of supporting database and file replication using Microsoft SQL Server Replication Services and Microsoft File Replication Services for providing distributed database replication across multiple ISMS application servers allowing for system expansion and delivering N tiers of server redundancy. Database and file replication shall not require any proprietary database or file replication software.

9. The ISMS shall conform to the standard TCP/IP networking communications protocol between the application server(s), client workstations, control panels, video surveillance equipment, and secondary subsystems using 10/100/1000Mb Ethernet connectivity over LAN/WAN network typologies.

10. The ISMS shall be flexible and scalable in architecture, permitting expansion of both capacity and functionality, to be implemented progressively as needed, through software licensing and/or software upgrades.

11. The ISMS shall provide the ability to perform network deployed software updates. Network deployed updates shall have the option to be deployed manually or automatically.

12. The ISMS shall provide a real-time display of all system status and data at all operator workstations.

13. The ISMS shall monitor status and record activity transactions of all secured areas and alarm input/output points; visually and audibly annunciate alarms upon change of status, for assessment and response at all operator workstations.

14. The ISMS shall monitor and record card access, alarm, and operator activity to an online history/archive database for reporting.

15. The ISMS shall employ distributed processing technology, allowing the host to function almost entirely as an application/database server. The majority of the real time, day-to-day decisions shall be made locally by intelligent control panels. The control panels shall be the direct field interface for all access control, alarm

sensing, and input/output-controlled devices.

16. Each control panel shall be able to continue access control and alarm-monitoring operations autonomously, in the event of ISMS hosting failure or network segment outage.

17. The ISMS shall manage and automatically download in real-time, all database changes made at all operator workstations, to the control panels that require notification of the specific database changes or updates. Manual operator initiated downloads of partial or complete control panel databases shall not be required for changes to take effect.

B. System Redundancy & High Availability: The ISMS shall provide multiple levels of communications redundancy and failover for all ISMS hosted controllers, digital video recorders, and client workstations. The ISMS shall be capable of automatically re-routing communications to alternate ISMS computers across the system without operator intervention.

1. ISMS system configurations with a single application/ database server shall provide at a minimum the following redundancy and failover capability:

2. The ISMS shall provide communications redundancy and failover for network-attached devices. Each network attached device (Control Panels and Digital Video Recorders) shall have one or more alternative communication sever(s) that can provide hosting in case of primary communications server failure.

3. In case of primary communications server failure, they system shall automatically re-route network-attached devices to their designated backup communications servers to allow continuous system operations without loss of alarm and event transaction processing during failover.

4. Network-attached devices which transition to backup communications servers, shall be able to be redirected back to their default primary servers, once the primary communications servers have been restored.

5. ISMS system configurations with multiple regional application/ database servers shall provide at a minimum the following redundancy and failover capability:

6. The ISM shall support the same level of communications redundancy and failover for network-attached devices per regional application/database server, allowable to span across regional application/database servers in the event of a regional application/database server failure.

7. In case of a regional application/database server failure, client workstations shall be able to failover to their designated backup regional application/database server to allow continuous system operations.

8. In case of a regional application/database server failure, upon server restoration, the ISMS shall automatically update and synchronize the regional

application/database server.

9. Client workstations which transition to a backup regional application/database server, shall be able to be redirected back to their default regional application/database server, once the regional application/database server functions have been restored.

C. System Capacity: Provide total system capacity to accommodate the following:

1. Application/Database Servers: Must be capable of supporting a Single application/database server upgradeable to a multi-server configuration with up to 64 synchronized application/database servers operating as a single unified system.

2. Workstations: Must be capable of supporting a minimum of 5 concurrent operator workstation sessions per server upgradeable to 100 concurrent operator workstation sessions per server.

3. Cardholder Database: Must be capable of supporting a minimum of 25,000 access control cards upgradeable to a minimum of 500,000 without restriction, limited only by available hard disk space and Microsoft SQL Server edition supported capacities. Multiple access control cards assignable per cardholder, each tracked separately. Access control cards shall be unique 4 to 20-digit numbers without facility code dependency.

4. Access Control Readers: Must be capable of supporting a minimum of 256 readers per server upgradeable to a minimum 4,096 without restriction per server.

5. General Purpose Alarm Inputs: Must be capable of supporting a minimum of 1,024 alarm input points per server upgradeable to a minimum of 16,384 without restriction per server.

6. General Purpose Outputs: Must be capable of supporting a minimum of 1,024 relayed or TTL level output points per server upgradeable to minimum of 16,384 without restriction per server.

7. Time Schedules: 255 with 16 individual intervals, concurrently active system wide.

8. Access Rights: Unlimited definable in system database.

9. Transactions: Centralized on-line storage of historical transactions, a minimum of 1,000,000 events without restriction, limited only by available hard disk space and Microsoft SQL Server edition supported capacities.

10. Video Surveillance Cameras: Must be capable of supporting a minimum of 256 per server upgradeable to a minimum of 4,096 without restriction per server.

D. Control Panel Capacities:

1. Field Configurable Control Panel:

    a. Card Readers: Capable of supporting up to 16 card readers with full door I/O.
    b. General Purpose Alarm Points: Capable of supporting up to 140 four-state supervised alarm input points.
    c. General Purpose Outputs: Capable of supporting up to 140 relay or TTL level output points.
    d. Access Control Card Memory: Up to 100,000
    e. Offline-History Transaction Buffer: Up to 16,000
    f. Time Schedules: Up to 255 with 16 individual intervals
    g. Uninterruptible Power Supply: Battery rated for a minimum 4 hours of continuous operation at full load.

2. Fixed Configuration Control Panel:

    a. Card Readers: Support 4 card readers with full door I/O, expandable to 8.
    b. General Purpose Alarm Points: Expandable to support up to 64 four-state supervised alarm input points.
    c. General Purpose Outputs: Expandable to support up to 64 Support 8 relay or TTL level output points.
    d. Access Control Card Memory: Up to 100,000.
    e. Offline-History Transaction Buffer: Up to 16,000.
    f. Time Schedules: Up to 255 with 16 individual intervals.
    g. Uninterruptible Power Supply: Battery rated for a minimum 4 hours of continuous operation at full load.

E. Operator Interface:

1. The ISMS shall use a single Windows based client application interface for system configuration management, administration, and monitoring operations.

2. The ISMS shall provide a mouse-driven, Windows based, graphical user interface allowing operator(s) to open and work on multiple application windows simultaneously, at host server and client workstation(s) with minimal degradation to system performance.

3. The ISMS shall provide on-line context sensitive help files to facilitate operators in the configuration and operation of the ISMS. Standard Windows help commands for Contents, Search, Back, and Print shall be supported.

4. The ISMS shall implement National Language Support (NLS) in a manner that allows simultaneous multi-lingual operation, based on individual operator language preference. The graphical user interface and on-line help shall support English and Spanish.

5. The ISMS shall support defining an unlimited number of operators; application access via workstation(s) shall be restricted by operator login and password.

Operator passwords shall be stored in the database in an encrypted manner. The ISMS shall provide that ability to setup password rules for password length and expiration periods for system operators. Operator profiles shall be configurable to include form level permissions, database partition views, and language preference.

6. The ISMS shall allow operator authentication through an Active Directory Server, bypassing ISMS storing passwords. Operator access with the ISMS shall continue to be defined within the ISMS configuration forms.

7. The ISMS shall support the use of thin client application deployment to provide remote access to the Operator Interface. Thin client application support shall be via standard Microsoft Terminal Services, Citrix MetaFrameXP and Microsoft Virtual Terminal Services using a standard web browser

F. Cardholder Management:

1. The ISMS shall provide an operator interface for enrollment, modification, and deletion of cardholder's personnel and access control information. The ISMS shall allow enrollment of cardholder's personnel and access control information in advance, without requiring assignment of access control card(s). The ISMS shall provide the ability to select multiple cardholders and badge records in applying mass changes. The cardholder's personnel and access information shall include the following data:

   a. First Name.
   b. Middle Name 1.
   c. Middle Name 2.
   d. Last Name.
   e. Employee Number.
   f. Personnel Type (Selectable from a user defined list that shall include at a minimum; Permanent, Temporary, Contractor, and Visitor classifications).
   g. Department (Selectable from a user defined list).
   h. Facility (Selectable from a user defined list of database partitioned views).
   i. Privileged APB policy holder (Enable/Disable)
   j. Address 1 (User definable label).
   k. Address 2 (User definable label).
   l. Address 3 (User definable label).
   m. Address 4 (User definable label).
   n. Address 5 (User definable label).
   o. Telephone.
   p. 90 User Fields (User definable labels).
   q. Access Right(s) and Area Exception(s) (Multiple assignments).
   r. Area Control Arm/Disarm Right(s) (Multiple assignments).
   s. Threat Level Access Clearance (Selectable from Normal, Low, Medium, High)
   t. Access Card(s) (Multiple assignments).

G. Card ID Management:

1. The ISMS shall provide an operator interface for enrollment, modification, and deletion of access control card ID information in advance, without requiring assignment to a cardholder and shall include the following data:

    a. Description.
    b. Card ID number (4 to 20 digit, unique access control identifier).
    c. Pin Number (4 digit number for authenticating cardholder in card & keypad reader applications).
    d. Status (Issuable, Active, Lost, Suspended, Remake).
    e. Assigned Cardholder (Selectable from predefined list of cardholders).
    f. Issue Date (Required to support advanced date issuance with automatic activation of access control card ID numbers at control panel level in real-time without ISMS host notification).
    g. Return Date.
    h. Expire Date (Required to support automatic expiration of access control card ID numbers at control panel level in real-time without ISMS host notification).

H. Access Control Management:

1. The ISMS shall allow or deny access to secured areas, arm and disarm areas, and provide output control via access control readers, based on validation of a cardholder's assigned access and area control rights.

2. The ISMS shall support defining an unlimited number of access rights in a manner that associates area(s) with time schedule(s). The time schedule(s) shall define the specific time(s) of day and day(s) of the week for which access will be granted for the associated areas(s).

3. The ISMS shall support defining activation and expiration dates per access right for issuance of temporary access authorization periods.

4. The ISMS shall support assignment of area exceptions in addition to access right assignments. Area exceptions shall support access policy assignments of (1) Allow access at all times, (2) Deny access at all times, (3) Allow access by schedule.

5. The ISMS shall allow cardholders to be assigned multiple access rights and multiple access control cards, without requiring duplicate database entry of cardholder personnel information.

6. Any and all access control cards assigned to a cardholder, shall automatically inherit all of the access rights, area exceptions, and area control rights assigned to the cardholder.

7. Threat level access clearance levels shall be assignable per cardholder for granting or denying access control requests based on a site's current threat level

status, irrespective of cardholder area access rights and access policy exceptions.

8. The ISMS shall allow threat level status per site to be changed manually by operators and automatically based on alarm events.

9. The ISMS shall support system wide enforcement policy for automatic card suspension based on usage days of inactivity.

10. The ISMS shall monitor all secured areas and process an alarm notification whenever a reader controlled door is opened, unless door is opened pursuant to a valid card read, exit request through egress device, or door has been manually unlocked via remote command from an authorized system operator.

I. Time Schedule and Mode Management: Schedules shall define time, day, and date intervals for automatically executing ISMS functions, events, and mode changes.

1. Time schedules: Shall define start and stop interval(s) by time of day and day of week or mode. Each time schedule shall support multiple intervals per day and multiple days per week. Time schedules shall be applicable to the following ISMS functions:

a. Cardholder access rights and area exceptions.
b. Readers online/offline.
c. Changing reader modes of operation between card only, card-plus-keypad, and card or keypad.
d. Doors lock/unlock.
e. Inputs enable/disable.
f. Outputs on/off.
g. Alarm monitoring on/off.
h. Area arm/disarm.
i. Area monitoring on/off.
j. Alarm transaction routing & bumping.

2. Mode Schedules: Shall define specific times and dates for indicating to system control panels which time scheduled functions to execute.

a. A minimum of 8 distinct mode classifications will be supported for categorizing time-scheduled functions.
b. System control panels shall support a minimum of 8 distinct modes for time-scheduled functions in a concurrent manner.

J. Reader / Door Control:

1. The ISMS shall allow access control readers to be individually configured for different applications and modes of operation and shall support the following:

a. Physical Reader Type: Each reader's physical mode of operation shall allow

to be manually changed by an operator, or automatically via a system time schedule, for increasing or decreasing the level of security required for accessing secured areas at any time.

1) Card Only.
2) Card-plus-keypad.
3) Card or Keypad.

b. Logical Reader Type: Each reader's logical mode of operation shall be configurable to support the following:

1) Normal
2) Anti-passback
3) Timed Anti-passback

c. Maximum unlock time after a valid card read shall be configurable from 0 to 59 minutes and 59 seconds.

d. Alarm sense time for allowing a door to remain open after a valid card read, before reporting a door held open alarm, shall be configurable from 0 to 61minutes and 59 seconds.

e. Extended unlock /alarm sense time after a valid card read shall be configurable from 0 to 59 minutes and 59 seconds, for cardholders requiring extended unlock duration times as in ADA applications. Cardholders and individual credentials for cardholders shall be configurable to initiate Extended unlock/sense functionality on doors configured to do so.

f. "Toggle" card reader control: In addition to normal time duration control, the system shall support configuring readers to switch between on /unlock and off/locked with each valid card read.

g. Door relock after a valid card read shall be configurable to support the following:

1) Lock on duration.
2) Lock on open.
3) Lock on close.

h. Reader / Door State:

1) Each reader shall support operating in a default on-line or off-line state, allowing to be manually changed by an operator, or automatically under a time of day and day of week schedule.
2) Each door shall support operating in a default locked or unlocked state, allowing to be automatically changed under a time of day and day of week schedule.
3) Each door, when scheduled to automatically unlock, shall be individually configurable to additionally require a valid card transaction to occur first before automatically executing the door unlock schedule.
4) Each door shall be individually configurable to monitor aperture of

the door after a valid access grant, validating actual passage of the cardholder.

i. Reader Transaction Routing:

1) Transactions for valid, invalid, and lost cards from each reader shall be independently configured for default routing to history/archive, system printer, and/or all operator workstations.

K. Elevator Control

1. The ISMS shall provide the ability to control access for calling of elevators cabs and selecting floor destination. The following elevator applications and configurations shall be supported:

a. Elevator Cab Access: Elevator cab call buttons shall be illuminated and enabled for selection when valid access via reader is granted.
b. Floor Access: Floor access shall be controlled via a reader located inside of each elevator cab; a minimum of 64 floors serviced by elevator cab(s) shall be controlled. Floor access shall support the following:

1) Non Floor Tracking: when an authorized card is presented to the reader located inside the elevator cab, only the floor buttons for the cardholder's corresponding assigned access will be illuminated and enabled for a user definable length of time to allow selection.

c. Elevator Public Access: Public access periods for floors assigned to designate areas shall be time schedule controlled.

L. Input/Output Control

1. The ISMS shall allow control panel input and output points to be individually defined, configured, and controlled in the following manner:

a. Input point(s) shall be user configurable for specific applications. The following application types shall be supported:

1) Alarm: digital input used to trigger an alarm and any selected output.
2) Digital Output: digital input used to trigger a selected input without alarm notification.
3) Arm/Disarm: digital input used to arm & disarm an area.
4) Elevator: digital input used for elevator control.
5) Inactive: digital input is disabled.

b. Input point(s) shall be user configurable to control output(s). Input point(s) configured for output control shall allow being enabled or disabled via time schedule.
c. Output point(s) shall support a user configurable duration time from 0 to 4 minutes and 15 seconds.

d. Output point(s) shall allow the active state to be configured as on or off.
e. Output point(s) shall be automatically controlled via time schedule to turn on or off.
f. Output points shall allow grouping to facilitate activating multiple output points.
g. Output point(s), including reader controlled doors, shall allow manual control by authorized operators in the following manner:

1) Activate/unlock for duration.
2) Activate/unlock indefinitely.
3) Deactivate/Lock.
4) Schedule override.
5) Text entry explaining reason for manual operator control shall be recorded in operator history/archive database.

M. Security Area Control:

1. Not Required For This Project.

N. Alarm Management

1. The ISMS shall allow alarms to be individually defined, configured, and controlled in the following manner:

a. Configure if monitoring of the alarm is enabled or disabled. An alarm shall allow monitoring to be controlled manually by an authorized operator and automatically via time schedule.
b. Alarm(s) shall be user configurable to trigger primary and/or secondary output(s).

1) The primary output shall be configurable to follow the alarm's state change or activate for it's defined output duration.
2) The secondary output shall be configurable to follow the alarm's state change or remain activated until manually reset or scheduled off.

c. Alarms shall allow grouping to facilitate monitoring multiple alarms, on or off, via time schedule and changing alarm sense times via event schedules.
d. Alarms shall support regrouping via event schedules, allowing alarms to be reassigned to different alarm groups.
e. Configure if the alarm shall be routed to the history/archive database and/or printed on a host/server alarm printer.
f. Alarms shall be able to be routed to specific workstations on specific time schedules. If an alarm is not responded to within a definable time period, it shall be able to be bumped to another workstation for acknowledgement.
g. User-definable instructions shall be assignable to each alarm, required to display in the alarm monitor window at all operator workstations for alarm assessment and response.
h. Configure if operator acknowledgement of the alarm is required before the

alarm can be cleared from the alarm monitor window from any operator workstation.

i. 20 priority levels for prioritizing the processing and display of alarms.
j. Configure and assign different foreground and background colors for the alarm text from a palette of 256 different colors, based on the alarm priority and state (Alarm, Reset, Bumped Alarm, Bumped Reset).
k. E-mail Alarm Notification: The ISMS shall be capable of providing Alarm notification to email address(s) or devices using a SMTP messaging protocol.

O. System Monitoring: The ISMS shall provide multiple monitoring application windows dedicated for displaying real-time information of ISMS card access and alarm activity as well as control panel and operator workstation status.

1. Activity Monitor: shall display card access and non-alarm event activity from all ISMS readers and relevant security devices that are on-line, active, and configured to route to monitor. The monitor window shall provide operator controls to clear, pause, and resume scrolling display of activity transactions. The following system activity transaction information shall be displayed:

a. Transaction date & time
b. Access Control Transaction types:

1) Valid (Access granted).
2) Valid Open (Access granted with door aperture confirmation).
3) Valid No Passage (Access granted with no door aperture detected).
4) Invalid (Access not granted).
5) Invalid Pin (Access not granted).
6) Max Invalid PIN (Access not granted, card suspended).
7) Suspended Card (Access not granted).
8) Lost Card (Access not granted).
9) Unknown Card (Access Not Granted).
10) Duress Valid.
11) Duress Invalid.
12) Duress Valid Open.
13) Duress Valid No passage.
14) Anti-Passback Violation.
15) Floor selection for elevator control.
16) Valid floor.
17) Invalid floor.

c. Cardholder name.
d. Card ID number for unknown or unassigned cards.
e. Security Area Transaction Types:

1) Area Armed.
2) Area Disarmed.
3) Arm/Disarm Failed, Area Not Secure.

4) Arm/Disarm Failed, Invalid Access Right.

f. Source device location description & reference.
g. The ISMS shall allow direct navigation from any event within the Activity Monitor to its related call-up of live and recorded video playback.

2. Alarm Activity Monitor: shall display alarm activity for all ISMS alarms configured or scheduled as monitored. The alarm activity monitor shall provide alarm notification and interaction for alarm assessment including acknowledgement and response. All operator acknowledgements and responses shall be recorded in the operator and alarm history/archive database. The following alarm activity information shall be displayed:

a. Priority.
b. Description.
c. Reference type or additional alarm information.
d. Alarm state:

1) Alarm.
2) Reset.
3) Cut (Tamper supervision).
4) Short (Tamper supervision).

e. Process state:

1) Acknowledged.
2) Unacknowledged.

f. Occurrence Count.
g. Host date and time.
h. Control panel date and time.
i. Predefined alarm instructions for operator assessment.
j. Entry for operator alarm response in free form text and from pick list of predefined alarm responses.
k. Acknowledgement button.
l. Alarm notification shall be provided via pop-up dialogue notifying the operator of the occurrence of a new alarm. Direct navigation from the notification dialogue to the Alarm Activity Monitor shall be provided.
m. The ISMS shall allow direct navigation from any alarm within the Alarm Activity Monitor to its related call-up of live and recorded video playback as well graphics map location.

3. Control Panel Monitor: shall provide real-time communications status and connectivity control of all ISMS control panels. The control panel monitor shall support and provide the following:

a. Display control panel properties, firmware version, and communications status.
b. The ability to remotely reset, configure online/offline, force database

downloads, and update control panel firmware.

4. Client Workstation Monitor: shall provide real-time communications status and connectivity control of all ISMS servers and client workstations.

5. Alarm Graphics Monitor: The system shall provide graphical map creation, editing, and real-time monitoring software for command & control visualization of ISMS alarms and device states via user configurable multi-state device symbols or icons.

    a. The following ISMS components shall be represented on graphics maps for monitoring and control: area/zones, cameras, client workstations, controllers, digital inputs, digital outputs, digital video recorders, reader, control points, and command groups.

    b. The ISMS shall allow a group of same or different devices to be represented by a single icon as a control point, such that the group is treated as a single object for alarm status purposes.
    c. The ISMS shall allow multiples of the same device type for the purpose of executing a single command on all the devices in the command group. Each command group icon can be defined as all devices of that type on the map, all devices of that type in a facility, or a user-defined set of devices.
    d. The ISMS shall provide a series of default icons and user definable custom icons in JPG, GIF, animated GIF, and PNG file formats. Variable sizes shall be supported in 16x16, 24x24, and 32x32 pixels.
    e. The ISMS shall support two icon techniques for alarm visualization: an overlay technique showing the state of the highest priority alarm on a device, and a decoration technique for displaying multiple alarms simultaneously for a device.
    f. The ISMS shall support creation and importing of images in JPG, GIF, or PNG file formats imported as a single layer base map.
    g. The ISMS shall support importing of multi-layer AutoCAD DXF R12 files, allow selected layers to be imported, and shall maintain layer separation within the system. The ISMS shall permit the re-import of a DXF file or individual layers from the file, without disturbing the other layers and icons previously placed on the map.
    h. The ISMS shall provide the ability to define map layers that can be dynamically turned on or off while editing and viewing during monitoring operations.
    i. The ISMS shall list maps alphabetically by facility in a navigation pane for easy access and additionally provide hyperlink icons that allow an operator to navigate and traverse through a series of maps quickly.
    j. The ISMS shall allow a default map defined per operator, such that the map automatically displays when the alarm graphics monitor window is launched. The user shall be able to size the alarm graphics monitor window as desired, maps, graphics symbols and icons shall maintain aspect ratios.
    k. The user shall be able to zoom in to the map using a mouse wheel or right

mouse click on a background point on the map.

l. The user shall be able to determine the state of each device by the icon's appearance, which shall change dynamically as alarms are set, reset, and cleared.

m. The user shall have right mouse button click access to the Alarm and Response Monitor from any symbol icon in an alarm state.

n. The user shall be able to initiate device control commands from a map using right mouse button click access of selected symbol icons. The control commands shall be device-type dependent and include the following:

1) Area – arm and disarm.
2) Cameras – launch live video.
3) Inputs – monitor on and off.
4) Outputs – activate on and off.
5) Reader/Doors – lock and unlock.

P. Database Reporting: The ISMS shall provide on-line database reporting without degrading system performance. The following reporting functions and capabilities shall be supported:

1. Predefined reports with the ability to create and save user definable templates for grouping, sorting, and filtering data. A minimum number of predefined reports shall be furnished covering the following topics:

a. Cardholder and card ID information.
b. System administration and device configurations.
c. System schedules and events.
d. Reader access.
e. Floor access.
f. Roll call / Muster.
g. Time and attendance.
h. Alarm history.
i. Person/Credential history.
j. Operator history.

2. Reports shall allow operators to perform page setup, preview report on-line, print, and export reports to multiple file formats and destinations.

a. Export file formats supported shall include:

1) Crystal Reports.
2) Data Interchange Format.
3) Excel.
4) HTML.
5) Lotus.
6) ODBC.
7) Paginated Text.
8) Report Definition.

9) Rich Text Format.
10) Tab Delimited Text.
11) Unformatted Text.
12) Word.

b. Export destinations supported shall include:

1) Disk File.
2) Exchange Folder.
3) Lotus Domino Database.
4) Microsoft Mail (MAPI).

3. The ISMS shall support direct database connectivity for facilitating report generation from external 3rd party database applications. The following applications shall be supported:

a. Microsoft SQL Server.
b. Microsoft Access.
c. Crystal Reports.

Q. Photo ID Card Production:

1. Not Required For This Project.

R. Application Program Interface:

1. Not Required For This Project.

2.3 SOFTWARE

A. Application & Database Server:

1. Enterprise Class Server Platform: Microsoft Server 2008 and with SQL Server 2008 64bit Server. System server shall be Owner provided.

B. Client Workstations:

1. Microsoft Windows Vista or Windows 7. Client Workstations shall be Owner provided.

C. Integrated Security Management System Software:

1. GE Security, Facility Commander Wnx 7.5

a. Licensed for a total of 4 client workstations.
b. Licensed for a total of 288 access control readers. This includes 10% expansion.

2. Licensed for a total of 0 digital video surveillance cameras.

3. Facility Commander Wnx 7.5 Photo ID Card Production Option. Not Required For This Project.

4. Licensed on 4 out of the total client workstations specified above.

2.4 HARDWARE

A. Host Server and Operator Workstations: Provided by Owner, to ISMS manufacturer's requirements specified below:

B. Host Server and Operator Workstations: Provided by ISMS supplier, factory-configured with all software pre-loaded and tested.

C. Computer requirements may vary based on system size and customer specific application requirements. Increasing memory capacity, hard drive capacity, processor speed, as well as specifying single dual core or dual processors, and multi-monitor displays shall be considered and recommended when required above minimum specifications.

1. Application & Database Server Minimum Requirements:

   a. 2.xGHz dual processor (Dual or Quad Core).
   b. 4 GB RAM.
   c. CDRW/DVD.
   d. 80GB HD, Raid-1 or Raid-10 Configuration
   e. 19-inch flat panel display, supporting 16bit high color at 1024x768 resolution.
   f. 10/100/1000MB Ethernet Network Interface Card.
   g. Standard 101-key keyboard and 2-button wheel mouse.

2. Operator Workstation Minimum Requirements:

   a. 2.xGHz processor (Dual or Quad Core)
   a. 2 GB RAM
   b. CDRW/DVD.
   c. 80GB HD
   d. 19-inch flat panel display, supporting 16bit high color at 1024x768 resolution,
   e. 10/100/1000MB Ethernet Network Interface Card.
   f. Standard 101-key keyboard and 2-button wheel mouse.
   g. Integrated sound with speakers.

D. Photo ID Card Production Hardware: Not Required For This Project.

E. Control Panels: GE Security, ACUXL16 series. The control panel shall be intelligent and fully stand-alone processor capable, making all local access control and alarm monitoring decisions without host server dependency. Control panel shall support and provide the following:

1. UL listed under UL 294 and UL 1076; FCC Part 15 and CE compliant.

2. Direct on-board support for industry standard RS232, RS485, and 10Mb Ethernet communications interfaces to ISMS host.

3. The 10Mb Ethernet NIC shall be onboard and support IT standard methods of communications with ISMS host via static IP addressing with native DES and AES encryption option enablement. PCMCIA Adapters, external terminal server, or external encryption hardware devices will not be acceptable.

4. Support redundant communications to ISMS host; primary communications via 10Mb Ethernet with automatic switchover to secondary communications via dial-up modem when detecting network failure.

5. Flashable memory support for facilitating remote firmware updates from ISMS host server and operator workstations; control panels shall remain on-line and operational during firmware update process.

6. The control panel shall support local database retention in the event of power failure. When primary power is restored, the control panel shall automatically attempt to establish communications with the ISMS host, in the event communications to ISMS host is not available, the control panel shall automatically return to operation with its last local database configuration.

7. Control panel cabinets shall be an industrial grade enclosure with knockouts outs for field wiring and have a key-locked and tamper protected door.

8. Low voltage power supply with uninterruptible battery backup allowing continued operations for a minimum of 4 hours at full load.

9. Each control panel shall be capable of sensing and reporting the following alarm conditions:

    a. Enclosure door tamper
    b. Primary power failure
    c. Low battery conditions
    d. Loss of communications

F. Control Panel Interface Modules: The ISMS control panels shall support on board and/or remote expansion interface modules via RS485 multi-drop configurations up to 4,000 feet from the control panel, for access control readers, alarm monitoring, and input/output control. Control panels shall support and provide the following as required:

1. Remote Reader Electronics (RRE) interfaces for access controlled doors:

a. The RRE interfaces shall provide complete door connectivity for readers, door contact switches, request-to-exit devices and electric locks.
b. The RRE interfaces shall have configurations available to support distributed connectivity of one, two, and four door nodes.
c. The RRE interfaces shall be housed in an industrial grade enclosure with knockouts outs for field wiring and have a key-locked and tamper protected door.
d. Each RRE interface shall be of a field serviceable design with on-board diagnostic LED's, pluggable terminal strips, and stand-off mounted PCB assembly for in-field replacement.
e. Each RRE interface shall support four-state supervised input points, output relays, and shall provide power outputs of 5 VDC, 12 VDC and 24 VDC output at 500 mA to power card readers, request-to-exit devices and door strikes.
f. Each RRE interface shall be capable of being powered from the central control panel or by a local 24 VDC source where required.
g. Each RRE shall support connectivity of card only, card-plus-keypad, and keypad only style readers of the following technologies:

1) Proximity.
2) Smart Card.
3) Magnetic Stripe.
4) Wiegand.
5) Barcode.
6) BaFe Touch.
7) Biometrics.

2. Remote Input Module (RIM) interface for alarm grade input point monitoring:

a. The RIM interface shall be housed in an industrial grade enclosure with knockouts outs for field wiring and have a key-locked and tamper protected door.
b. Each RIM interface shall be of a field serviceable design with on-board diagnostic LED's, pluggable terminal strips, and stand-off mounted PCB assembly for in-field replacement.
c. Each RIM shall support 16 four-state supervised input points and two output relays. The status of each input point shall be indicated by a tri-state LED.
d. Each RIM interface shall be capable of being powered from the central control panel or by a local 24 VDC source where required.

3. Remote Relay Module (RRM) interface for relay output control:

a. The RRM interface shall be housed in an industrial grade enclosure with knockouts outs for field wiring and have a key-locked and tamper protected door.
b. Each RRM interface shall be of a field serviceable design with on-board diagnostic LED's, pluggable terminal strips, and stand-off mounted PCB

assembly for in-field replacement.

c. Each RRM shall support eight SPST and eight DPDT output relays. The status of each output point shall be indicated by a tri-state LED.

d. Each RRM interface shall be capable of being powered from the central control panel or by a local 24 VDC source where required.

2.5 NETWORK INTELLIGENT CONTROLLER

A. General:

1. The Networked Intelligent Controller (NIC) shall be a microprocessor-based device, which utilizes a 32-bit processor and a 32-bit bus structure. The controller shall have a minimum clock speed of 90 MHz, and shall be provided with at least 16 Mbytes of battery backed dynamic RAM. The controller shall feature a direct LAN/WAN connection to the controller bus structure in addition to two RS-232 or RS-485 connections, all of which should be designed for use in communication with the ACAM server. The communication architecture of the NIC shall be such that in the event that the primary communication channel to the ACAM server is lost, the unit shall be capable of automatically switching to a secondary communication channel using one of the host RS-232 or RS-485 connections, and if required shall be able to establish communications via dial-up modem.

2. The NIC shall be provided with a parallel printer port, which will enable it to print transaction data during loss of communication with the ACAM server. The NIC shall be capable of dynamically allocating its memory between database information and transaction history, which shall be stored if the controller has lost communication with the ACAM server. Such transaction history shall be automatically uploaded to the ACAM server once communication has been restored. In its maximum configuration, the NIC shall be capable of storing 250,000 cardholders, and its memory utilization shall be such that if storing database information for 10,000 cardholders, it shall also be capable of storing 500,000 transactions.

3. The NIC shall support the monitoring and control of 16 card readers, with or without keypads. It shall also be provided with at least 12 five-state, fully supervised and fully configurable input points, and at least 12 fully configurable auxiliary output control relays mounted on the main circuit board.

4. Each controller must also be capable of expansion, by external Remote Input Modules (RIMs) and/or Remote Relay Modules (RRMs), to support a combination of up to 172 fully configurable five-state supervised input points or 156 output relays per NIC depending on configuration.

5. Each NIC shall be provided with a UL Listed uninterruptible power supply (UPS) mounted within the NIC enclosure. It shall provide sufficient battery backup to

sustain complete operational effectiveness including Remote Reader Electronic (RRE) modules, card readers, electric locks (fail secure), RIMs and RRMs for a minimum of four [eight] hours of normal operation.

6. Each NIC shall utilize on-board self-diagnostic LEDs, removable terminal strips and a pop-in/pop-out circuit board.

7. Each NIC in addition to its on-board LAN/WAN connection shall support RS-232 and multi-drop RS-485 communication topologies. Provision of external LAN terminal server devices that are connected though serial communications to the NIC are not acceptable.

8. Each NIC shall support RS-485 bi-directional communication paths (dual multi-drop paths back to ACAM file server) with no additional hardware or firmware required.

9. Each NIC shall be supplied with all specified options available, including a locking enclosure with a tamper switch.

10. Each NIC shall be capable of reporting the following alarm conditions to the ACAM file server:

    a. enclosure door tamper
    b. primary power failure
    c. low battery conditions
    d. loss of communications
    e. all access control violations.

11. The Network Intelligent Controller shall be a GE Security ACULX 16

2.6 REMOTE READER ELECTRONIC MODULES

A. General

1. The Remote Reader Electronic (RRE) modules shall be provided to support all card readers, door contact switches, request-to-exit devices and electric locks. The RRE modules shall support all industry standard card reader technologies (magnetic stripe, Wiegand, bar code, barium ferrite, and proximity) as well as keypads and compatible biometric devices. These modules shall be available in configurations suitable to support the connection of one, two or four card devices as required.

2. Each RRE module shall support five-state supervised input points, output relays, and shall provide power outputs of 5-VDC, 12-VDC and 24-VDC output at 500-Ma to power card readers, biometric devices, request to exit (REX) devices and door strikes. Each RRE module shall be capable of being powered by the on-board UPS of a NIC to avoid the need for power supplies and 115-volt outlets to be located near controlled doors. Each RRE shall also be capable of being

powered by a local 24-VDC UPS where required.

3. RRE modules shall utilize on-board self-diagnostic LEDs, removable terminal strips and pop-in/pop-out circuit boards.

4. RRE modules shall be supplied with all specified options available, including an enclosure with an enclosure tamper switch.

5. Contractor shall utilize GE produced Four (4) door RREs due to the high number of card readers. Single and Dual RREs may be provided as required.

6. Quantity and location of RRE modules shall be as specified in Contract Documents and drawings.

2.7 ACULX 16 NETWORK INTELLIGENT CONTROLLER POWER SUPPLY

A. The ACULX 16 requires a power supply/charger that transforms 120 VAC to 27.5 VDC. The Contractor shall provide the ACU-8APWR power supply/charger assembly to power the ACULX 16 and the supporting RREs. The ACU-8APWR becomes an uninterruptible power supply when stand-by batteries are connected. It has a special power limiting circuit that allows the batteries to be charged. The batteries are protected with an automatic resetting circuit breaker and diode for over current and accidental reversed battery hookup. Float charging means faster recovery time for the batteries. There is no switch over or voltage drop when power fails. Contractor shall furnish Gel-cell backup batteries as specified by the manufacturer.

2.8 ACCESS CONTROL POWER SUPPLY

A. Electrified locksets shall be powered from the ACUXL16 panel.

2.9 CARD READERS

A. Proximity Card Readers

1. Provide surface mounting style 125 KHz proximity card readers suitable for wall or US 2-S single-gang box mounting, and for mounting configurations as shown on the project plans.

2. The reader shall be capable of reading access control data in standard Wiegand formats up to 84 bits in length from any HID Proximity card or equivalent, outputting the data in one of the following configurations:

   a. The card reader shall output credential data in compliance with the SIA AC-01 Wiegand standard, compatible with all standard access control systems.
   b. The card reader shall output credential data using a Clock and Data

interface, and be compatible with systems requiring a magnetic stripe reader.

3. The reader shall be capable of outputting a periodic reader supervision message at a configurable time interval, enabling the host system to signal an alarm condition based on the absence of this message.

4. The Proximity card reader shall provide the ability to change operational features in the field through the use of a factory-programmed command card. Command card operational programming options shall include:

    a. Reader beeps and flashes green on a card read, LED normally red, single line control of LED.
    b. Reader flashes green on a card read, LED normally red, single line control of LED.
    c. Reader beeps on a card read, LED normally red, single line control of LED.
    d. Beeper and LED are controlled by host only, LED normally red, single line control of LED.
    e. Reader beeps and flashes green on a card read, LED normally off, red and green LED's controlled individually.
    f. Reader flashes green on a card read, LED normally off, red and green LED's controlled individually.
    g. Reader beeps on a card read, LED normally off, red and green LED's controlled individually.
    h. Beeper and LED are controlled by host only, LED normally off, red and green LED controlled individually
    i. Change from Wiegand to Mag Stripe output format
    j. Change from Mag Stripe to Wiegand output format
    k. Reset to Factory Defaults

5. Proximity card readers shall provide the following programmable audio/visual indication:

    a. A piezoelectric sounder shall provide an audible tone upon successful power up/self test, good card read, or whenever the beeper control line is asserted by the host.
    b. A bi-color, red/green LED shall light upon successful power up/self test, good card read, or whenever the LED control line(s) are asserted by the host.
    c. The reader shall have individual control lines for the sounder, and for red and green LED indication. When the LED control lines are asserted simultaneously, an amber LED indication will occur.

6. The reader shall have a configurable hold input, which when asserted shall either buffer a single card read or disable the reader, until the line is released. This input may be used for special applications or with loop detectors.

7. The reader shall require that a card, once read, must be removed from the RF field

for one second before it will be read again, to prevent multiple reads from a single card presentation and anti-passback errors.

8. Proximity card readers shall meet the following physical specifications:

   a. Dimensions: 4.70 x 3.0 x 0.68" (11.9 x 7.6 x 1.7 cm)
   b. Weight: 3.3.oz (94 g)
   c. Material: UL94 Polycarbonate
   d. Two-part design with separate reader body and cover.
   e. Color: Black, Gray, White or Beige as approved by the project architect.

9. Proximity card readers shall meet the following electrical specifications:

   a. Operating voltage: 5– 16 VDC, reverse voltage protected. Linear power supply recommended.
   b. Current requirements: (average/peak) 20/115mA @ 12 VDC

10. Proximity card readers shall meet the following environmental specifications:

    a. Operating temperature: -22 to 150 degrees F (-30 to 65 degrees C)
    b. Operating humidity: 0% to 95% relative humidity non-condensing
    c. Weatherized design suitable to withstand harsh environments The reader shall be of potted, polycarbonate material, sealed to a NEMA rating of 4X (IP55).

11. Proximity card reader cabling requirements shall be:

    a. Cable distance: Wiegand: 500 feet (150m); Clock & Data: 50 feet (15m)
    b. Cable type: 5-conductor #22 AWG w/overall shield. Additional conductors will be required for 2-line LED control, beeper, hold, or card present functions.
    c. Standard reader termination: 18" (.5m) cable pigtail

12. Warranty of Proximity card readers shall be lifetime against defects in materials and workmanship.

13. Proximity card reader shall be HID Corporation Model Thinline II.

B. Proximity Card Reader (Mullion Mount)

1. Provide surface mounting style 125 KHz proximity card readers suitable for door or window mullion mounting, and for minimal space mounting configurations as shown on the project plans.

2. The reader shall be capable of reading access control data in standard Wiegand formats up to 84 bits in length from any HID Proximity card or equivalent, outputting the data in one of the following configurations:

   a. The card reader shall output credential data in compliance with the SIA AC-01 Wiegand standard, compatible with all standard access control systems.

b. The card reader shall output credential data using a Clock and Data interface, and be compatible with systems requiring a magnetic stripe reader.

3. The reader shall be capable of outputting a periodic reader supervision message at a configurable time interval, enabling the host system to signal an alarm condition based on the absence of this message.

4. The Proximity card reader shall provide the ability to change operational features in the field through the use of a factory-programmed command card. Command card operational programming options shall include:

   a. Reader beeps and flashes green on a card read, LED normally red, single line control of LED.
   b. Reader flashes green on a card read, LED normally red, single line control of LED.
   c. Reader beeps on a card read, LED normally red, single line control of LED.
   d. Beeper and LED are controlled by host only, LED normally red, single line control of LED.
   e. Reader beeps and flashes green on a card read, LED normally off, red and green LED's controlled individually.
   f. Reader flashes green on a card read, LED normally off, red and green LED's controlled individually.
   g. Reader beeps on a card read, LED normally off, red and green LED's controlled individually.
   h. Beeper and LED are controlled by host only, LED normally off, red and green LED controlled individually
   i. Change from Wiegand to Mag Stripe output format
   j. Change from Mag Stripe to Wiegand output format
   k. Reset to Factory Defaults

5. Proximity card readers shall provide the following programmable audio/visual indication:

   a. A piezoelectric sounder shall provide an audible tone upon successful power up/self test, good card read, or whenever the beeper control line is asserted by the host.
   b. A bi-color, red/green LED shall light upon successful power up/self test, good card read, or whenever the LED control line(s) are asserted by the host.
   c. The reader shall have individual control lines for the sounder, and for red and green LED indication. When the LED control lines are asserted simultaneously, an amber LED indication will occur.

6. The reader shall have a configurable hold input, which when asserted shall either buffer a single card read or disable the reader, until the line is released. This input may be used for special applications or with loop detectors.

7. The reader shall require that a card, once read, must be removed from the RF field for one second before it will be read again, to prevent multiple reads from a single card presentation and anti-passback errors.

8. Typical proximity card read range shall be up to:

    a. 5.5" (14 cm) using HID Proxcard II card.
    b. 5" (12.5 cm) using HID ISOProx or DuoProx cards
    c. 2" (5 cm) using HID ProxKey II key fob
    d. 2.5" (6.25 cm) using HID Microprox Tag
    e. 5" (12.5 cm) using HID iCLASS Prox
    f. 2" (5.0 cm) using HID Prox/Wiegand Card

9. Proximity card readers shall meet the following physical specifications:

    a. Dimensions: 6.0 x 1.7 x 1.0" (15.2 x 4.3 x 2.54cm)
    b. Weight:

        1) Terminal Strip: 3.5 oz (99 gm)
        2) Pigtail: 3.8 oz (108 gm)

    c. Material: UL94 Polycarbonate
    d. Two-part design with separate reader body and cover.
    e. Color: Black, Gray, White or Beige as approved by the project architect.

10. Proximity card readers shall meet the following electrical specifications:

    a. Operating voltage: 5 – 16 VDC, reverse voltage protected. Linear power supply recommended.
    b. Current requirements: (average/peak) 20/110mA @ 12 VDC
    c. Proximity card readers shall meet the following certifications:
    d. UL 294
    e. Canada/UL 294
    f. FCC Certification
    g. Canada Radio Certification
    h. EU and CB Scheme Electrical Safety
    i. EU – R&TTE Directive
    j. CE Mark (Europe)
    k. C-Tick (Australia)
    l. New Zealand
    m. Taiwan
    n. Korea
    o. China

11. Proximity card readers shall meet the following environmental specifications:

    a. Operating temperature: -22 to 150 degrees F (-30 to 65 degrees C)
    b. Operating humidity: 0% to 95% relative humidity non-condensing
    c. Weatherized design suitable to withstand harsh environments The reader

shall be of potted, polycarbonate material, sealed to a NEMA rating of 4X (IP55).

12. Proximity card reader cabling requirements shall be:

    a. Cable distance: Wiegand: 500 feet (150m); Clock & Data: 50 feet (15m)
    b. Cable type: 5-conductor #22 AWG w/overall shield. Additional conductors will be required for 2-line LED control, beeper, hold, or card present functions
    c. Standard reader termination: 18" (.5m) cable pigtail
    d. Optional reader termination: 10 screw terminals located under reader cover.

13. Warranty of Proximity card readers shall be lifetime against defects in materials and workmanship.

14. Proximity card reader shall be HID Corporation MiniProx, base P/N 5365 (Wiegand) and 5368 Clock and Data)

2.10 LINE SUPERVISION

A. Communications between the host computer and the data gathering panels shall be protected against compromise. The system shall detect substitution of resistance or electrical potential, substitution of like equipment, and introduction of synthesized signals. Protective circuits (alarm inputs) shall be protected between the data gathering panel and the sensing devices (door contacts, motion detectors, etc.). Each circuit shall be supervised by end or line resistors located at the sensing device. The system shall detect resistance changes and report alarm and trouble signals at designated values defined by the system manufacturer. The system shall register a minimum of four (4) states: normal, alarm, trouble open (cut), and trouble closed (shorted). Trouble signals shall be displayed to the operator in a format readily identifiable by the operator as a supervisory condition.

2.11 SYSTEM SENSORS AND RELATED EQUIPMENT

A. The EECS (Electronic Entry Control System) and related Equipment provided by the Contractor shall meet or exceed the following performer specifications:

B. Request To Exit Detectors:

1. The electrified door hardware provided by the Division 8 Door Hardware Contractor shall feature an integrated request to exit device. Electrified door hardware shall be installed by the Division 8 Door Hardware Contractor. The Security Contractor is responsible for performing final terminations to the EECS.

C. Magnetic Contacts

1. Recessed Single Pole Double Throw Door Contact

   a. The door contact shall contain a hermetically sealed magnetic reed switch. The reed shall be potted in the contact housing with a polyurethane based compound. Contact and magnet housing shall snap-lock into a 25.4 mm (1 in) diameter hole. Housing shall be molded of flame retardant abs plastic. Color of housings shall be off-white, grey or mahogany brown. Choice of color to depend on door decor. The contact shall contain a single pole double throw (SPDT) switch with an open or closed loop. Contacts and magnets shall be treated with a thin coat of RTV silicone to hold the contact and magnet in place. Card reader controlled doors, biased and recessed perimeter door contacts, shall be GE model # 1078 or equivalent.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall install all system components and appurtenances in accordance with the manufacturers' instructions, ANSI C2, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified. Control signals, communications, and data transmission lines grounding shall be installed as necessary to preclude ground loops, noise, and surges from affecting system operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with manufacturers' recommendations and as modified herein.

B. Consult the manufacturers' installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all schematic system installation/termination/wiring data.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

3.2 CURRENT SITE CONDITIONS

A. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions which will affect performance of the system to the Owner in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Owner.

3.3 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval. All forms shall be completed in accordance with specified timelines outlines in Group Technical Data Packages in Section 280500.

1. Record setup data for control station and workstations.

2. For each Location, record setup of Controller features and access requirements.

3. Access Lists

4. Propose start and stop times for time zones and holidays, and match up access levels for doors.

5. Set up groups, facility codes, linking, and list inputs and outputs for each Controller.

6. Assign action message names and compose messages.

7. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.

8. Prepare and install alarm graphic maps.

9. Develop user-defined fields.

10. Develop screen layout formats.

11. Propose setups for guard tours and key control.

12. Discuss badge layout options; design badges.

13. Complete system diagnostics and operation verification.

14. Prepare a specific plan for system testing, startup, and demonstration (see the Testing section for requirements).

15. Develop acceptance test concept and, on approval, develop specifics of the test.

16. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

17. Develop data gathering panel matrices that conform to Section 280500.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

E. All Programming and access lists are submitted, reviewed, and accomplished before any devices are terminated and/or tested.

PART 4 - SYSTEM PROGRAMMING

4.1 REFER TO 280500 PART 4

PART 5 - TESTING AND ACCEPTANCE

5.1 REFER TO 280500 PART 5

END OF SECTION 281300

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Refer to 280500 Part 1

1.2 RELATED DOCUMENTS

A. Refer to 280500 Part 1

1.3 RELATED DIVISION PROVISIONS

A. Refer to 280500 Part 1

1.4 REFERENCES

A. Refer to 280500 Part 1

1.5 SUMMARY

A. This Section includes video management system which consists of cameras, data transmission wiring, and a control station with its associated equipment.

B. The video surveillance system shall be integrated with monitoring and control system specified in Division 28 Sections “Common Work Results for Electronic Security”, “Intrusion Detection”, and “Access Control" which specifies systems integration.

1.6 DEFINITIONS

A. Refer to 280500 Part 1

1.7 SUBMITTALS

A. Refer to 280500 Part 1

1.8 COORDINATION

A. Refer to 280500 Part 1

1.9 QUALITY ASSURANCE

A. Refer to 280500 Part 1

1.10 MAINTENANCE & SERVICE

A. Refer to 280500 Part 1

1.11 SYSTEM DESCRIPTION

A. The system shall be coordinate with 280500.

1.12 PERFORMANCE REQUIREMENTS

A. Refer to 280500 Part 1

1.13 DELIVERY HANDLING & STORAGE

A. Refer to 280500 Part 1

1.14 PROJECT CONDITIONS

A. Refer to 280500 Part 1

1.15 EQUIPMENT AND MATERIALS

A. Refer to 280500 Part 1

1.16 ELECTRICAL POWER

A. Refer to 280500 Part 1

1.17 ENVIRONMENTAL CONDITIONS

A. Refer to 280500 Part 1

1.18 LIGHTNING, POWER SURGES, & GROUNDING

A. Refer to 280500 Part 1

1.19 COMPONENT ENCLOSURES

A. Refer to 280500 Part 1

1.20 ELECTRONIC COMPONENTS

A. Refer to 280500 Part 1

1.21 SUBSTITUTE MATERIALS & EQUIPMENT

A. Refer to 280500 Part 1

1.22 LIKE ITEMS

A. Refer to 280500 Part 1

1.23 WARRANTY

A. Refer to 280500 Part 1

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following are acceptable manufacturers of electronic security system products as specified in this specification section. Any proposed product from a different manufacturer is subject to the review procedures in Section 1.05 in this specification.

1. Closed Circuit Television:

   a. Mobotix

2. Video Recording and Storage:

   a. Network Attached Storage (NAS) appliance - Owner Provided, Contractor Installed

2.2 VIDEO SURVEILLANCE SYSTEM

A. The Contractor shall configure the Color CCTV system as specified and shown on the Contract Documents and Drawings. All distances shown are approximate and shall be verified by the Contractor.

B. The system shall include all interior and exterior housings, mounts, connectors, adapters, and terminations necessary for the interconnection of the video surveillance system. The Contractor shall also supply and install all cabling necessary to interconnect the video equipment installed in the Security Operations Center.

1. The new video system shall consist of all (CMOS) Cameras, Newtork Attached Storage (Owner Provided, Contractor Installed), and network transmission devices, necessary to integrate with the Owner's existing Video Head-End Equipment.

2. The Video System shall provide operator interface, interaction, control of cameras. The cameras shall continuously view selected locations and/or display operator selections.

C. Computer Software

1. Video management software is provided by Manufacturer at no additional charge.

2. Owner is responsible for installing and configuring video management software.

2.3 360º CAMERAS

A. The 360º Camera shall meet or exceed the following specifications:

1.	Lenses	L11(hemispheric)
2.	Sensitivity	Color: 1 lux (t-1/60s), 0.05 lux (t=1/1s) B/W: 0.1 lux (t-1/60s), 0.005 lux (t-1/1s)
3.	Sensor	½" CMOS, progressive scan
4.	Max. Image Resolution	Color: 2048 x 1536 (3 MEGA) Black/White: 1280 x 960 (MEGA)
5.	Image Format	Free image format selection (from 160 x 120 to 2040 x 1536); with L11: PTZ view, Quad view, panorama broad view image, double panorama view, panorama focus with 3 views
6.	Max Frame Rate (M-JPEG) (Live/Recording)	VGA: 25 fps, TV-PAL: 18 fps, MEGA 8 fps, 3 MEGA: 4 fps
7.	Video Stream (MxPEG) (Live/Recording)	VGA: 30 fps, TV-PAL: 30 fps, MEGA: 30 fps, 3 MEGA: 20 fps
8.	Image Compression	MxPEG, M-JPEG, JPEG, H.263 (only Video-VoIP)
9.	Internal DVR	MicroSD slot (camera-internal video recording up to 32GB)
10.	External Storage	Directly on NAS and PC/Server without additional recording software
11.	Software (Inclusive)	Video management software MxEasy, Control room software MxControlCenter
12.	Image Processing	Backlight compensation, automatic white balance, image distortion correction (panorama image correction included), video sensor (Motion Detection)
13.	Virtual PTZ	Digital Pan/Tilt/Zoom, continuous 8x zoom
14.	Alarm/Events	Triggering of events by integrated multiple-window motion detection, temperature sensor, notification over email, FTP, IP telephony (VoIP, SIP), visual/acoustic alarm, pre-and post alarm images

15.	Audio	Integrated microphone and speaker, lip-synchronous audio, two-way speaker, audio recording
16.	Interfaces	Ethernet 10/100, USB, MxBus
17.	Video Phone	VoIP, SIP, two-way speaker, remote control via DTMF signaling, event notification
18.	Security	User-/Group management, HTTPS/SSL, IP address filter, IEEE 802.1x, intrusion detection, digital image signature
19.	Certificates	EMC (EN50121-4, EN55022, EN55024, EN61000-6-2, FCC part 15B, AS.NZS3548)
20.	Power Supply	Power over Ethernet (802.3af): PoE class variable depending on operating mode; power consumption; typ. 3W; with PoE switch/MOBOTIX PoE – Adapter
21.	Operating Conditions	IP65 (DIN EN 60529), -30 to +60 ºC (-22 to +140 ºF)
22.	Dimensions	Ø x H: 16 x 5 cm, weight: ca. 450 g
23.	Standard Delivery	Housing (high resistance composites – PBT-PC), white, incl. 360º lens, mounting parts, allen wrench patch cable – 50cm, manual, software, 4 GB Micro SD (except Basic)

B. 360º Camera shall be the Q24 Hemispheric camera by Mobotix, or Owner approved equal.

C. The Contractor shall provide camera mounts and mounting hardware as described in the Contract Documents.

D. Contractor shall coordinate all camera views with the Owner prior to procuring cameras and camera lenses. Contractor responsible for performing all calculations necessary to provide optimal camera images in accordance with Owner's guidance. All camera images must be verified by the Owner or Owner's representative prior to final adjustment.

2.4 SINGLE VIEW FIXED DOME CAMERA

A. The Single View Fixed Dome Camera shall meet or exceed the following specifications:

1.	Lenses	22 to 135 mm format,

		Horizontal angle 90º to 15º
2.	Sensitivity	Color: 1 lux (t-1/60s), 0.05 lux (t=1/1s) B/W: 0.1 lux (t-1/60s), 0.005 lux (t-1/1s)
3.	Sensor	½" CMOS, progressive scan
4.	Max. Image Resolution	Color: 2048 x 1536 (3 MEGA) Black/White: 1280 x 960 (MEGA)
5.	Image Format	2048 x 1536, 1280 x 960, 1024 x 768, 800 x 600, 768 x 576 (D1), 704 x 576 (TV-PAL), 640 x 480, 384 x 288, 352 x 288, 320 x 240, 160 x 120; free image format selection (e.g. 1000 x 200 for skyline)
6.	Max Frame Rate (M-JPEG) (Live/Recording)	VGA: 25 fps, TV-PAL: 18 fps, MEGA 8 fps, 3MEGA: 4 fps
7.	Video Stream (MxPEG) (Live/Recording)	VGA: 30 fps, TV-PAL: 30 fps, MEGA: 30 fps, 3MEGA: 20 fps
8.	Image Compression	MxPEG, M-JPEG, JPEG, H.263 (only Video-VoIP)
9.	Internal DVR	MicroSD slot (camera-internal video recording up to 32GB)
10.	External Storage	Directly on NAS and PC/Server without additional recording software
11.	Software (Inclusive)	Video management software MxEasy, Control room software MxControlCenter
12.	Image Processing	Backlight compensation, automatic white balance, image distortion correction
13.	Virtual PTZ	Digital Pan/Tilt/Zoom, continuous 8x zoom
14.	Alarm/Events	Triggering of events by integrated multiple-window motion detection, temperature sensor, notification over email, FTP, IP telephony (VoIP, SIP), visual/acoustic alarm, pre-and post alarm images
15.	Audio	Optional via ExtlIO, lip-synchronous audio, two-way speaker, audio recording, video VoIP supported

16.	Interfaces	Ethernet 10/100, USB, MxBus
17.	Video Phone	VoIP, SIP, two-way speaker, remote control via DTMF signaling, event notification
18.	Security	User-/Group management, HTTPS/SSL, IP address filter, IEEE 802.1x, intrusion detection, digital image signature
19.	Certificates	EMC (EN50121-4, EN55022, EN55024, EN61000-6-2, FCC part 15B, AS.NZS3548)
20.	Power Supply	Power over Ethernet (802.3af): PoE class variable depending on operating mode; power consumption; typ. 3W; with PoE switch/MOBOTIX PoE – Adapter
21.	Operating Conditions	IP65 (DIN EN 60529), -30 to +60 ºC (-22 to +140 ºF)
22.	Dimensions	∅ x H: 16 x 8.6 cm, weight: ca. 350 g
23.	Standard Delivery	Housing (high-resistance composites – PBT), white, shockproof polycarbonate dome (transparent), free choice of lenses, mounting parts, allen wrench, patch cable – 50cm, manual, software, 4 GB Micro SD (except Basic)

B. Fixed Dome Camera shall be the D24 MonoDome by Mobotix, or Owner approved equal.

C. The Contractor shall provide camera mounts and mounting hardware as described in the Contract Documents.

D. Contractor shall coordinate all camera views with the Owner prior to procuring cameras and camera lenses. Contractor responsible for performing all calculations necessary to provide optimal camera images in accordance with Owner's guidance. All camera images must be verified by the Owner or Owner's representative prior to final adjustment.

2.5 DUAL VIEW FIXED DOME CAMERA

A. The Dual View Fixed Dome Camera shall meet or exceed the following specifications:

1.	Lenses	22 to 135mm format Horizontal angel 90º to 15 º
2.	Sensitivity	Color: 1 lux (t-1/60s), 0.05 lux (t=1/1s)

		B/W: 0.1 lux (t-1/60s), 0.005 lux (t-1/1s)
3.	Sensors	2 x ½" CMOS, progressive scan
4.	Max. Image Resolution	Color: 2048 x 1536 (3 MEGA) Black/White: 1280 x 960 (MEGA)
5.	Image Format	2048 x 1536, 1280 x 960, 1024 x 768, 800 x 600, 768 x 576 (D1), 704 x 576 (TV-PAL), 640 x 480, 384 x 288, 352 x 288, 320 x 240, 160 x 120; free image format selection (e.g. 1000 x 200 for skyline)
6.	Max Frame Rate (M-JPEG) (Live/Recording)	VGA: 16 fps, TV-PAL: 12 fps, MEGA 6 fps, 3MEGA: 4 fps
7.	Video Stream (MxPEG) (Live/Recording)	VGA: 30 fps, TV-PAL: 24 fps, MEGA: 14 fps, 3MEGA: 10 fps
1.	Image Compression VoIP)	MxPEG, M-JPEG, JPEG, H.263 (only Video-
2.	Internal DVR	SD slot (up to 32GB), 16GB internal (Sec-R16)
3.	External Storage	Directly on NAS and PC/Server without additional recording software
4.	Software (Inclusive)	Video management software MxEasy, Control room software MxControlCenter
5.	Image Processing	Backlight compensation, automatic white balance, image distortion correction, video sensor (motion detection)
6.	Virtual PTZ	Digital Pan/Tilt/Zoom, continuous 8x zoom
7.	Alarm/Events	Triggering of events by integrated multiple-window motion detection, temperature sensor, notification over email, FTP, IP telephony (VoIP, SIP), visual/acoustic alarm, pre-and post alarm images
8.	Audio	Integrated microphone and speaker, Line-In/Line-Out, lip-synchronous audio, two-way speaker, audio recording
9.	Interfaces	Ethernet 10/100, ISDN, RS232, 3 x In, 1 x Out

10.	Video Phone	VoIP, SIP, two-way speaker, remote control via DTMF signaling, event notification
11.	Security	User-/Group management, HTTPS/SSL, IP address filter, IEEE 802.1x, intrusion detection, digital image signature
12.	Certificates	EMC (EN55022, EN55024, EN61000-6-2, FCC part 15B, AS.NZS3548)
13.	Power Supply	Power over Ethernet (802.3af; Class 0), Netpower-Adapter, typ. 4W
14.	Operating Conditions	IP54/IP65 (without/with wall mount), -30 to +60 ºC (-22 to +140 ºF)
15.	Dimensions	∅ x H: 20.1 x 11 cm, weight: ca. 650 g
16.	Standard Delivery	Housing (high-resistance composites – PBT), white, shockproof polycarbonate dome (transparent), free choice of lenses, mounting parts, allen wrench, patch cable – 50cm, manual, software, 4 GB Micro SD (except Basic)

B. Dual View Fixed Dome Camera shall be the D12 DualDome by Mobotix, or Owner approved equal.

C. The Contractor shall provide camera mounts and mounting hardware as described in the Contract Documents.

D. Contractor shall coordinate all camera views with the Owner prior to procuring cameras and camera lenses. Contractor responsible for performing all calculations necessary to provide optimal camera images in accordance with Owner's guidance. All camera images must be verified by the Owner or Owner's representative prior to final adjustment.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall install all system components and appurtenances in accordance with the manufacturer's instructions, ANSI C2, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified. Control signals, communications, and data transmission lines grounding shall be installed as necessary to preclude ground loops, noise, and surges from affecting system operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with manufacturers' recommendations and as modified herein.

1. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all schematic system installation/termination/wiring data.

2. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

B. Current Site Conditions: The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Owner in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Owner.

C. Conduit and Wire: Refer to 280513 – Conductors and Cables for Electronic Security

3.2 CLOSED CIRCUIT TELEVISION

A. Installation: The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2, and shall furnish all necessary connectors, terminators, interconnections, services, adjustments and licenses required for a complete and operable video system.

B. Interconnection Video Equipment: The Controller shall connect signal paths between video equipment of 250' or less with Cat 5e cable. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

C. Cameras: The Contractor shall install the cameras with the proper focal length lens as indicated for each zone; connect power and signal lines to the camera; set cameras with fixed iris lenses to the proper f-stop to give full video level; aim camera to give field of view as needed to cover the alarm zone; aim fixed mount cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun; focus the lens to give a sharp picture over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected.

D. Video Recording Equipment: The Contractor shall install the video recording equipment as shown and as specified by the manufacturer; connect video signal inputs and outputs as shown and specified; connect alarm signal inputs and outputs as shown and specified; and connect video recording equipment to AC power.

E. Video Signal Equipment: The Contractor shall install the video signal equipment as specified by the manufacturer and as shown; connect video or signal inputs and outputs as shown and specified; terminate video inputs as required; connect alarm signal inputs and outputs as required; connect control signal inputs and outputs as required; and connect electrically powered equipment to AC power.

F. System Start Up: The Contractor shall not apply power to the CCTV system until the following items have been completed:

1. CCTV system equipment items and DTM have been set up in accordance with manufacturer's instructions.

2. A visual inspection of the CCTV system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.

3. System wiring has been tested and verified as correctly connected as indicated.

4. All system grounding and transient protection systems have been verified as properly installed and connected as indicated.

5. Power supplies to be connected to the system have been verified as the correct voltage, phasing, and frequency as indicated.

6. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3.3 WIRELINE DATA TRANSMISSION

A. Installation: The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2 and as shown, and shall furnish all necessary connectors,

terminators, interconnections, services, and adjustments required for a complete and operable data transmission system.

B. Identification and Labeling: The Contractor shall supply permanent identification labels for each cable at each end that will appear on the as-built drawings. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified by type or signal being carried and termination points. The labels shall be printed on letter size label sheets that are self laminated vinyl that can be printed from a computer data base or spread sheet. The labels shall be E-Z code WES12112 or equivalent.

1. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.

C. Transient Voltage Surge Suppressors (TVSS): The Contractor shall mount TVSS within 3 m (118 in) of equipment to be protected inside terminal cabinets or suitable NEMA 1 enclosures. Terminate off-premise conductors on input side of device. Connect the output side of the device to the equipment to be protected. Connect ground lug to a low impedance earth ground (less than 10 ohms) via Number 12 AWG insulated, stranded copper conductor.

D. Contractor's Field Test: The Contractor shall verify the complete operation of the data transmission system during the Contractor's Field Testing. Field test shall include a bit error rate test. The Contractor shall perform the test by sending a minimum of 1,000,000 bits of data on each DTM circuit and measuring the bit error rate. The bit error rate shall not be greater than one (1) bit out of each 100,000 bits sent for each dial-up DTM circuit, and one (1) bit out of 1,000,000 bits sent for each leased or private DTM circuit. The Contractor shall submit a report containing results of the field test.

E. Acceptance Test and Endurance Test: The wire line data transmission system shall be tested as a part of the completed IDS and EECS during the Acceptance test and Endurance Test as specified.

F. Identification and Labeling: The Contractor shall supply identification tags or labels for each cable. Cable shall be labeled at both end points and at intermediate hand holes, manholes, and junction boxes. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified with type of signal being carried and termination points.

3.4 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras level and plumb.

B. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system component enclosures, and mounted in self-protected, inconspicuous positions.

C. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification of Electrical Systems."

3.5 PROGRAMMING

A. Refer to 280500, Part 3

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of video surveillance equipment.

B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

C. Pretesting: Refer to 280500, Part V

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions and to optimize performance of the installed equipment. Tasks shall include, but are not limited to, the following:

1. Check cable connections.

2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.

3. Adjust all preset positions; consult Owner's personnel.

4. Recommend changes to cameras, lenses, and associated equipment to improve Owner' utilization of video surveillance system.

5. Provide a written report of adjustments and recommendations.

3.8 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video surveillance system components, including camera-housing windows, lenses, and monitor screens.

PART 4 - SYSTEM PROGRAMMING

4.1 REFER TO 280500 PART 4

PART 5 - TESTING AND ACCEPTANCE

5.1 REFER TO 280500 PART 5

END OF SECTION 282300

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fire alarm systems.

B. Include system internal provision for future interface to the security system related to the release of egress door upon building evacuation alarms.

C. Related Sections include the following:
1. Division 28, Section 283113 – Emergency Notification System

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Noncoded, voice evacuation, addressable system; multiplexed signal transmission dedicated to fire alarm service and emergency notification system.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Fire alarm signal initiation shall be by one or more of the following devices:
1. Manual stations.
2. Smoke detectors.
3. Heat detectors.
4. Verified automatic alarm operation of smoke detectors.
5. Automatic sprinkler system water flow.

C. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciator.
3. Release fire doors held open by magnetic door holders
4. Transmit an alarm signal to the remote alarm receiving station.
5. Activate voice/alarm communication system.
6. Initiate the digital alarm communicating transmitter (DACT).
7. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
8. Record events in the system memory.
9. Record events by the system printer.
10. Recall elevators to primary or alternate recall floors.

D. Supervisory signal initiation shall be by one or more of the following devices or actions:
1. Operation of a fire-protection system valve tamper.
2. Operation of a duct mounted smoke detector.

E. System trouble signal initiation shall be by one or more of the following devices or actions:
1. Open circuits, shorts and grounds of wiring for addressable initiating device, signaling line, and addressable notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.

F. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event in the system memory.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
1. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire alarm system design.
   b. Fire alarm certified by NICET, minimum Level III.
2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
3. Device Address List: Coordinate with final system programming.
4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
6. Batteries: Size calculations.
7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
8. Voice/Alarm Signaling Service: Equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

9. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Owner for review.

G. Documentation:
1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, and authorities having jurisdiction.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 WARRANTY

A. Warranty Period and Coverage: Two years from date of Substantial Completion. Warranty shall cover manufacturer's standard form in which manufacturer and installer agree to repair or replace system devices and equipment that fail in materials or workmanship within specified warranty period. Warranty work shall include all labor on a 24 hour per day, 7 days per week basis.

B. Provide complete system inspection and testing every 6 months, after the initial installation, testing, and inspection, for the duration of the warranty. Submit to the College a written report of the inspection. Correct all deficiencies found during the inspection and testing of the system.

C. All warranty work shall be provided to the College at no additional cost.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.

3. Smoke and Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, no substitution:
1. FACP and Equipment:
   a. SimplexGrinnell LP; a Tyco International Company.
2. Wire and Cable:
   a. Comtran Corporation.
   b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
   c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
   d. West Penn Wire/CDT; a division of Cable Design Technologies.

2.2 FACP

A. General Description:
1. Modular, power-limited design with electronic modules, UL 864 listed.
2. Addressable microprocessor based fire alarm control panel.
3. Addressable initiation devices that communicate device identity and status.
   a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
   b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
4. Addressable control circuits for operation of mechanical equipment.
5. Addressable notification appliances.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, three lines of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:
1. Signaling Line Circuits: NFPA 72, Class B, Style 4.
   a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.
2. Notification-Appliance Circuits: NFPA 72, Class B, Style Y.
3. Actuation of alarm notification appliances, emergency voice communications, annunciation, and actuation of suppression systems shall occur within 10 seconds after the activation of an initiating device.

D. Smoke-Alarm Verification:
   1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
   2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
   3. Record events in the system memory.
   4. Sound general alarm if the alarm is verified.
   5. Cancel FACP indication and system reset if the alarm is not verified.

E. Elevator Recall:
   1. Smoke detectors at the following locations shall initiate automatic elevator recall.
      a. Elevator lobby detectors except the lobby detector on the designated floor.
      b. Smoke detector in elevator machine room.
      c. Smoke detectors in elevator hoistway.
   2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
   3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
      a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

F. Door Controls: Door hold-open devices that are controlled by smoke detector at door in smoke barrier walls shall be connected to fire-alarm system.

G. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

H. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

I. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciator, after initiating devices are restored to normal.
   1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
   2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
   3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

J. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

L. Transmission to Remote Alarm Receiving Station
   1. Provide digital alarm communication transmitter (DACT) for supervisory and alarm signals via two telephonic lines. Transmitted information shall include alarm initiating device and location, similar to information listed on the control panel LCD display.

2. Provide all network ports and RS 232 jacks.
3. Provide BACNet remote annunciation provisions.

M. Voice/Alarm Signaling Service: A central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of the FACP.
1. Indicated alarm channels for automatic, transmission of announcements, or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall be UL 1711 listed.
a. Programmable tone and message sequence selection.
b. Standard digitally recorded messages for "Evacuation" and "All Clear."
c. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACP.
2. Notification-Appliance Circuits: NFPA 72, Class B.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

N. Ports: Ports shall be RS-232 for connection to external peripheral equipment. The port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

O. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal and supervisory signal shall be powered by the 24-V dc source.
1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

P. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
1. Batteries: Sealed lead calcium.
2. Battery and Charger Capacity: Comply with NFPA 72.

Q. Surge Protection:
1. Install surge protection on normal ac power for the FACP and its accessories. Surge protection shall be integral to the FACP.
2. In addition, install external surge protection on normal ac power to the FACP. Surge protection shall be as manufactured by Ditek, DTK-HW Series.

R. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

S. Security System Interface: Addressable relays for interface to the security system.

2.3 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key- or wrench-operated switch.

2.4 SYSTEM SMOKE DETECTORS

A. General Description:
1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type. Indicating detector has operated status.
6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

B. Ionization Smoke Detector:
1. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
2. Detector Sensitivity: Between 0.5 and 1.7 percent/foot smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:
1. Photoelectric Smoke Detectors:
   a. Sensor: LED or infrared light source with matching silicon-cell receiver.
   b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate-of-rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.
   1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
   2. All notification appliances shall be addressable.

B. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
   1. Rated Light Output: 15 candela minimum unless otherwise indicated.
   2. Strobe Leads: Factory connected to screw terminals.

C. Voice/Tone Speakers:
   1. UL 1480 listed.
   2. Low-Range Units: Rated 1 to 2 W.
   3. Mounting: Flush, semirecessed, or surface mounted; bidirectional as indicated.
   4. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

2.7 REMOTE FIREFIGHTERS' COMMUNICATION SERVICE

A. Dedicated, supervised, push-to-talk microphone voice communication links between the FACP and remote firefighters' station. Supervised telephone lines shall be connected to talk circuits. Activation of microphone activates all speakers for announcements. Microphone shall have higher priority than evacuation message. Provide the microphone in a flush mounted factory red finish glass door cabinet adjacent to the remote annuciator.

2.8 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Flush cabinet, NEMA 250, Class 1 at the entrance vestibule.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

C. Annunciator panel shall be smoke plexiglas, back lighted with appropriate LEDs. Provide graphic as indicated on the drawing with photo emulsion material.

2.9 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

2.10 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG and size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
   1. Low-Voltage Circuits: No. 16 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.
   3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, galvanized steel armor, red striped, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke Detector Spacing:
   1. Smooth ceiling spacing shall not exceed the rating of the detector.
   2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
   3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

E. Audible Alarm-Indicating Devices: Install as indicated on the drawings.

F. Visible Alarm-Indicating Devices: Install as indicated on the drawings.

G. Device Location-Indicating Lights: Locate in public space near the device they monitor.

H. FACP: Surface mount with tops of cabinets not more than 72 inches above the finished floor.

I. Annunciator: Install with top of panel not more than 72 inches above the finished floor. Flush mount the cabinet at the entrance vestibule.

J. System printer: Install the system printer on stand adjacent the fire alarm control panel.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:
   1. NECA 1.
   2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems" and rated cables according to Division 26 Section “Low Voltage Electrical Power Conductors and Cables”. Provide raceways and cables in accordance with the following:
   1. Major system distribution: Provide conductor in metal raceway for all system wiring between the FACP, voice evacuation control panel (VACP), all Fire Alarm Terminal Cabinets (FATC) and Fire Alarm Extender Panels (FAEP) as indicated on the drawings. Terminate all system conductors on terminal strips in each FATC. Provide a minimum of 50 percent spare conductors for alarm initiating circuits, alarm notification circuits and other control wiring associated with the fire alarm system. Terminate spare conductors on terminal strips in each FATC. Label each system conductors terminating in the FACT and provide a typed legend in the cover of the FATC identifying all active and spare conductors. These conductors will be considered and labeled on the drawing as the back bone of the system and are intended to meet future system wiring needs.
   2. Lateral distribution system: Provide MC cable from the FATC to the system alarm initiating devices, alarm notification devices and control wiring associated with the fire alarm system. Conceal cables in finished spaces.
   3. Annunciator Panel: Provide system conductors in metal raceway from the FACP to the remote annunciator panel. Provide a minimum of 50 percent spare conductors in the raceway and terminate spare conductors on terminal strips.
   4. Firefighter’s two-way communication station: Provide system conductors in metal raceway from the FACP to the equipment.
   5. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the FACP and the remote equipment. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification for Electrical Systems."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
   2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
   3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
   4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
   5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

C. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 283111

SECTION 283113 - EMERGENCY NOTIFICATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. UTP cabling.
   2. Amber visual appliances.
   3. Message boards.
   4. Modular links to fire alarms system control panel.
   5. Exterior speakers

B. Related Sections include the following:
   1. Division 28, Section 283111 – Digital, Addressable Fire Alarm System

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

A. Noncoded, addressable system, with multiplexed signal transmission, dedicated to emergency notification system and fire-alarm service.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Emergency notification events shall be initiated from the existing PC system located in the Security Office located at the Second Floor of The Science and Applied Studies (SA) building. Emergency announcements will be either pre-recorded or will be live announcements.

C. Emergency notifications can be identical to all facilities on campus or can be specific to a particular building while sending a different message to alternate buildings. Facility identifications are keyed to the building fire alarm control panel.

D. Making an emergency announcement will initiate the following actions:

1. Operate amber visual appliances in all facilities. Initiation of the visual appliance will be driven from local building fire alarm control panels.
2. Audible announcements will be made through the fire alarm system's speakers. Prior to the actual announcement, a pre announcement whoop will be sent to the speakers. The initial whoop will be distinctive and different than the whoop sent to speakers for building evacuation due to a fire event.
3. Message boards will scroll text and display written directives specific to the emergency. Message boards are activated through a Lite Link server installed in the College's IT rack.
4. Exterior speakers are made operational with the emergency announcement through the transmitter.

E. System Priority: Emergency Notification System will have a higher priority over building evacuation signals due to a fire event.

F. Speaker Array
1. The electronic directional speaker array shall provide adequate coverage of the exterior areas. The frequency response shall be uniform from to ensure excellent voice reproduction.
2. Speaker array control.
3. The control must be battery operated and use programmable tone generators and modular 400 watt off the shelf amplifiers capable of undistorted voice and warning tone reproduction. The design must minimize wiring and simplify component removal and installation. The control must allow for various power level configurations with common parts between each configuration.

1.6 SUBMITTALS

A. General Submittal Requirements:
1. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified fire-alarm technician, Level III minimum.
   c. Licensed or certified by authorities having jurisdiction.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For emergency notification system. Include plans, elevations, sections, details, and attachments to other work.
1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include performance parameters and installation details for each appliance, verifying that each appliance is listed for complete range of coverage.
3. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Qualification Data: For qualified Installer.

E. Field quality-control reports.

F. Operation and Maintenance Data: For emergency notification systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.

3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

G. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

H. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Owner for review.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Test systems to and demonstrate full system operation in conjunction with the operation of the fire alarm system.

1.8 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps for Strobe Units: Provide 2 units.
   2. Message boards: Provide 2 units.

1.10 WARRANTY

A. Warranty Period and Coverage: Two years from date of Substantial Completion. Warranty shall cover manufacturer's standard form in which manufacturer and installer agree to repair or replace system devices and equipment that fail in materials or workmanship within specified warranty period. Warranty work shall include all labor on a 24 hour per day, 7 days per week basis.

B. Provide complete system inspection and testing every 6 months, after the initial installation, testing, and inspection, for the duration of the warranty. Submit to the College a written report of the inspection. Correct all deficiencies found during the inspection and testing of the system.

C. All warranty work shall be provided to the College at no additional cost.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, no substitution:
   1. Appliances, links, transmitters and related and equipment:
      a. SimplexGrinnell LP; a Tyco International Company.
   2. Wire and Cable:
      a. Comtran Corporation.
      b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
      c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
      d. West Penn Wire/CDT; a division of Cable Design Technologies.
   3. Message boards
      a. Inova Solutions, through SimplexGrinnell.

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden CDT Inc.; Electronics Division.
   2. Berk-Tek; a Nexans company.
   3. CommScope, Inc.
   4. Draka USA.

B. Description: 100-ohm, four-pair UTP.
   1. Comply with TIA/EIA-568-B.2, Category 6.
   2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Technology Systems Industries, Inc.
   2. Dynacom Corporation.
   3. Hubbell Premise Wiring.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Outer jacket: Provide outer jacket color to distinguish cable from other facility IT and data cabling. Provide pink outer jacket color. Coordinate and verify final color with the College.

D. Connecting Blocks: 110 style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare; integral with connector bodies, including plugs and jacks where indicated.

2.4 MESSAGE BOARDS

A. Message boards shall be as manufactured by Inova Solutions and meet the following requirements:
   1. LED message board, three colors (red, yellow, and green).
   2. LED diameter: 0.2 inch.
   3. LED spacing/pitch: 0.3 inch.
   4. Character set: Block/Profile/Upper/Lower: Sans serif.
   5. Presentation mode: Scroll up, ribbon left.
   6. Time/Date: 12/24 hour time formats, multiple date formats.
   7. Data interface: TCP/IP connectivity, supports DHCP and static IP addressing, with automatic IP address discovery system, supports SNTP
   8. Power: IEEE 802.3af compatible, 15.4 watts max using Power over Ethernet switch.
   9. Agency approval: CE marked.
   10. Case material: Black molded plastic over steel frame.
   11. Mounting: Include hardware for ceiling mounting.
   12. Weight: 6 lbs
   13. Dimensions: 30.9 inch by 6.9 inch by 2.3 inch.

2.5 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.

B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal amber polycarbonate lens mounted on an aluminum faceplate. The word "ALERT" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
   1. Rated Light Output:
      a. As noted on the drawings in cd.
   2. Mounting: Wall mounted unless otherwise indicated.
   3. Flashing shall be in a temporal pattern, synchronized with other units.
   4. Strobe Leads: Factory connected to screw terminals.
   5. Mounting Faceplate: Factory finished, white.

2.6 EXTERIOR SPEAKER SYSTEM

A. CONTROL UNIT SPECIFICATIONS

1. Amplifiers
   a. To ensure clear voice and tone reproduction, the amplifier output must be uniform to within +3dB over the 300 - 3000Hz range. Distortion must be less than 3%.
   b. The amplifiers must 400 watt amplifiers and be modular for easy replacement. It must be possible to remove and install an amplifier simply “plug and play”.
   c. The amplifiers must incorporate protection circuitry to protect against short circuit and over temperature conditions. Protection circuitry must reset when the fault is removed.
   d. The Amplifiers shall be housed in a NEMA4X enclosure.

B. RADIO CONTROL EQUIPMENT

1. The radio, decoder, timer-unit (RDT-U) shall be housed within the lockable NEMA rated enclosure, it may be located in a separate housing or an integral part of the siren control system – including:
   a. Quantity – as shown on drawings controller, receiver –timer-decoder units, programmed onto a MHz frequency determined by the FCC.
   b. Quantity – as shown on drawings, omni directional antenna(s) with antenna mount(s), cable con, for VHF radio capabilities.
   c. The Owner shall be capable of activating the system using one-way activation.
   d. In addition, the new system shall also have a two-way FSK control system for monitoring capabilities by the County.

C. RADIO

1. The FM Receiver shall be programmable, dual frequency conversion, superheterodyne receiver capable of accepting +7.5 Khz frequency modulation in the MHz range.
2. Power supply shall be 120 VAC, 60 Hz, single phase. It may be self contained or part of a siren power supply.
3. Radio Frequencies – as determined by the FCC.
4. Sensitivity – Usable sensitivity, high band 0.25UV.
5. Selectivity – 6 dB bandwidth Khz minimum and 60 dB bandwidth_20Khz maximum.
6. Image and spurious – Response greater than –70dB.
7. RF Stability – 0.0005% from –30 to 60 degrees C.

D. ZONING

1. A zoning function must be available to enable the control of individual sirens.
2. Siren tones must ramp up in volume at startup to allow people working in close proximity a chance to take action to avoid hearing damage. The ramp must start below 5 watts power output and not reach full power for at least 5 seconds.

E. BATERRY AND CHARGING SYSTEM

1. Batteries
   a. The batteries must be locally available, sealed and maintenance free. The vendor shall specify the type of battery to be purchased.

b. Batteries must provide enough power for 30 minutes of continuous operation. Without charge, the batteries must be able to back up the siren for at least 10 days with enough reserve for a 5 minute activation at the end of 10 days.

2. Charger

Specifications:

a. Operating Voltage: Solar Power and/or 120 or 240 VAC ±20%, 50-60 Hz.
b. AC Current Draw: 5A AC max.
c. Current Output: 8-10 A DC min.
d. Protection: Short circuit and over voltage
e. The charger must not cause radio interference.

3. Solar Photovoltaic (PV) Panels
   a. General: Solar power and battery equipment shall be fully integrated with the speaker array to allow the complete system to operate independently of any external power source.
   b. Operating Characteristics:
      1. Solar panel shall generate DC electrical power to operate battery charger to charge batteries. Panels shall be warranted to provide 80% of minimum power after 25 years of service.
      2. A manually set or fixed voltage solid state voltage regulator shall be provided. Minimum current rating shall be twenty (20) ampres.
      3. Siren Equipment shall operate off of battery system as specified above.
   c. All solar mounting brackets shall be sized to accommodate a minimum of 2 each 110W panel.

F. LOCAL DIAGNOSTICS

1. Local diagnostic indications must be available. The following minimum indications must be provided:
   a. Door Open
   b. AC Fail
   c. Power
   d. Auxiliary
   e. Cancel
2. A low power mode must be available to test each siren function using the amplifiers and speakers at a low level (below five watts).
3. A quiet test function must be provided to test the amplifiers and drivers at a frequency above the human hearing range. The status of this test must be easy to access within the siren controller.

G. REMOTE DIAGNOSTICS

1. Critical siren operating conditions must be monitored and made available to the remote monitoring station. The minimum status conditions to be monitored are:
   a. Siren Status of Site #
   b. Date Time
   c. RF Communication
   d. Batteries
   e. Cabinet Intrusion
   f. Power
   g. Amplifiers and Speakers
   h. Siren Status
   i. Siren Counter (how many activation or polls)
2. Changes in status must be automatically reported to the monitoring station unless the siren is activated. When activated, the siren will only respond when requested to report to minimize traffic in an emergency.

H. CONTROL OPTIONS ON THE RTU

1. At least five siren functions and CANCEL must be controllable using both:
   a. Local push-button controls
   b. Remote contact closure inputs.
2. All possible siren functions including the five functions and one function for broadcast P.A.

I. RELAY OUTPUT

1. A 15 amp DC fused relay contact closure output must be available. This relay must close whenever a siren function is active. An LED indicator must light whenever the relay contact is closed.

J. CABINETS

1. The cabinets must be constructed of aluminum or fiberglass which will endure harsh environmental locations.
2. The electronics housing shall have a NEMA4X rating. The batteries must be in a separate vented enclosure. Connections between cabinets must be sealed against the flow of air or battery gasses. Convenient mounting brackets shall be included for pole or wall mounting.
3. A lock shall be provided for each cabinet.

2.7 OMNI-DIRECTIONAL AND DIRECTIONAL SPEAKER ARRAY SPECIFICATIONS

A. DIRECTIONAL CAPABILITY

1. The siren must be stationary and must not rotate the speaker or the sound field to disperse the sound. The speaker assembly must be directional in configuration allowing for manipulating the horns to meet the changing topographical locations. For example, a horn may be turned-in a downward angle or from side to side to meet the contours of the coverage area or avoid direct obstacles.

B. MECHANICAL CHARACTERISTICS

1. The speakers must be mechanically sound with the ability to withstand up to 100 mph winds. Pole mounting brackets shall be included.
2. The compression drivers must not be exposed to the environment. Access panels must in the rear of the speaker horn is provided for easy driver replacement.
3. 35' of speaker cable must be included with the siren. Cable must be weather/solar resistant.

2.8 ENVIRONMENTAL

A. The siren must be able to operate in various outdoor weather conditions including rain, ice, snow, and blowing sand without detriment to the siren or acoustic output.

1. Operating Temperature Range: -30 to +60 C
2. Humidity: 0 - 98%
3. Wind: 100 mph min.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of emergency communication system equipment.

B. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph (160-km/h) wind load with a gust factor of 1.3 without damage.

3.2 CABLING

A. Data cabling shall be routed through the horizontal installation pathway via 'J'hooks, or ceiling straps.

B. All horizon copper data cable runs shall be continuous runs, with no splices, with no length exceeding 295 feet or 90 meters.

C. All cable runs must maintain 10 foot service loops at both ends of the cable. The service loops at the work area end of the cable is placed in the ceiling.

D. All cables must be labeled according to the labeling section of this document.

E. Final connection at the IT switch will be provided by the College.

F. Labeling: Label each cable in accordance with the following criteria:
1. Each label shall include, at a minimum, the physical address of the component, any physical extensions, and/or terminations.
2. Cables shall be labeled at each end.
3. Each cable shall have a unique identifier.
4. The identifier shall be marked directly on the cable or the label affixed to the cable.
5. Labels shall be made of durable material such as vinyl.
6. Labels shall be suitable for wrapping and bending.
7. Labels shall be consistent across an installation.
8. All labels shall be easy to see.
9. Coordinate final labeling with the College.

3.3 CABLE TESTING

A. All new cable installations shall be tested after installation according to current Industry Standards. A written copy of all tests shall be provided to the College project manager at completion of the tests. The college also demand 'End-to-End' testing of all cabling plants after Infrastructure equipment is installed. This test is mandatory for all installations and all cables. In the case of telephone jacks a 'dial tone' test is performed. In the case of data drops, network connectivity is tested

B. All category 6 cables shall be tested to and pass ANSI/TIA/EIA 568 B.2, which recognizes category 6. Contractor tests shall utilize a category 6 compliant cable tester. Electronic results for each UTP category 6 four-pair cable will be submitted as part of the Contractor's "As-Built" project performance acceptance records. In addition to the above information, the documentation will also include a pass/fail indication for the specified cable, the test date, the serial number and software version of the scanner, and a copy of the calibration certificate for the scanner. Necessary applications for reading the results will be provided

by the requirements-refer to ANSI/TIA/EIA 568-B.2. This document can be found in the “TIA/EIA Telecommunications Building Wiring Standards.” A written copy of all tests shall be provided to the IT Project Manager after completion.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 INSTALLATION OF EXTERIOR SPEAKER SYSTEM

A. Provide turn-key installation of the system. Provide the roof mounts and all materials necessary for a complete installation. All cabling shall be enclosed in galvanized steel conduit. PVC pipe will not be acceptable. The Siren Head, each cabinet, and the antenna shall be individually grounded. The installer shall test and verify that all ground wires are properly installed. Installation shall include verification of the radio alignment, including insuring that forward and reflective power are within acceptable levels.

B. Installation shall be such that signal will distribute from existing facility roofs considering a perimeter wall at the roof’s edge to be 8 feet in height. Provide required structure to elevate speaker array accordingly for sound distribution above the perimeter wall.

C. Upon completion of the installation, the manufacturer will perform System Optimization/Commissioning Services to confirm correct installation and programming, check all system components and insure complete system operation.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
      b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Emergency Notification system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain emergency notification system.

END OF SECTION 283113

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities and abandoning site utilities in place.
7. Temporary erosion- and sedimentation-control measures.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
2. Division 01 Section "Execution" for field engineering and surveying.
3. Division 01 Section(s) "Construction Waste Management and Disposal.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: In accordance with Montgomery College's General Conditions of the Contract.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.

6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Division 01 and the approved Forest Conservation Plans.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect/Engineer.

3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect/Engineer and College's Representative not less than 14 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in Division 22, Division 26 and Division 33 Sections.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Use only hand methods for grubbing within protection zones.
3. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses and plants.
2. Excavating and backfilling for structures.
3. Subbase course for concrete walks and pavements.
4. Subbase course and base course for asphalt paving.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation" for recording pre-excavation and earth moving progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
3. Divisions 22, 26 and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
4. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
5. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
6. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by College's Representative.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by College's Representative.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1/2 cu. yd. for bulk excavation and for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Rock shall be defined as those materials that cannot be excavated with a Caterpillar Model No. 345 L track type hydraulic excavator, weighing not less than 99,000 lbs, equipped with a 30-inch wide short-tip radius rock bucket, rated not less than 345 hp flywheel power with a bucket-digging force of not less than 39,000 lbs or equivalent machinery.
2. Bulk Excavation: Rock shall be defined as those natural materials which cannot be excavated in an open excavation with a Caterpillar Model D-8, heavy duty track –type tractor, weighted at not less than 285 hp flywheel and equipped with a single-shank hydraulic ripper, capable of exerting not less than 45,000 lbs breakout force, or equivalent machinery.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches.
2. Warning Tape: 12 inches long; of each color.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

E. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Preexcavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect/Engineer.

C. Utility Locator Service: In accordance with Montgomery College's General Conditions of the Contract.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section "Temporary Facilities and Controls", Division 31 Section "Site Clearing," are in place.

E. Do not commence earth moving operations until plant-protection measures specified in Temporary Tree and Plant Protection are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, SM, GC, SC, and ML according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: Less than 45.
2. Plasticity Index: Less than 20.

C. Unsatisfactory Soils: Soil Classification Groups OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C 33; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state. complying with Maryland Pond 378 Standards and Specifications.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288:

1. MDSHA Class PE Type 1 Nonwoven.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288:

1. MDSHA Class SE Woven.

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A.

B. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

1. Perform blasting without damaging adjacent structures, property, or site improvements.
2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Division 01 and Approved Forest Conservation Plans.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: As indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection" and approved Forest Conservation Plans.

3.8 SUBGRADE INSPECTION

A. Notify Architect/Engineer when excavations have reached required subgrade.

B. If Contactor's geotechnical testing agency determines that unsatisfactory soil is present, Contractor's geotechnical testing agency is to provide recommendations to the College's Representative, Architect/Engineer on how to proceed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 10tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Contractor's Testing Agency, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Montgomery College's General Conditions of the Contract.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect/Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi , may be used when approved by Architect/Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect/Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Comply with WSSC Standard Specifications and Standard Details for water and sanitary sewer construction.

C. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

D. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 100 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch .
2. Walks: Plus or minus 1 inch .
3. Pavements: Plus or minus 1/2 inch .

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.

4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 100 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 100 percent of maximum dry unit weight according to ASTM D 698.

3.18 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect/Engineer.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect/Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect/Engineer.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment with termiticide.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include the EPA-Registered Label for termiticide products.

B. Product certificates.

C. Soil Treatment Application Report: Include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Warranties: Sample of special warranties.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

C. Preinstallation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.5 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: Five years from date of Substantial Completion.

1.6 MAINTENANCE SERVICE

A. Continuing Service: Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Corporation, Agricultural Products; Termidor.
b. Bayer Environmental Science; Premise 75.
c. FMC Corporation, Agricultural Products Group; Talstar.
d. Syngenta; Demon TC.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.2 APPLYING SOIL TREATMENT

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

C. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

D. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
4. Masonry: Treat voids.
5. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

F. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

G. Post warning signs in areas of application.

H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Contractor shall comply with the latest edition of Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials (January 2001) and all approved addenda, except Method of Measurement and Basis of Payment.

1.2 SUMMARY

A. Section Includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Pavement-marking paint.

B. Related Sections:

1. Division 31 section “Earth Moving” for aggregate subbase and base course and for aggregate pavement shoulders.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
2. Job-Mix Designs: For each job mix proposed for the Work.

B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Samples: For each paving fabric, 12 by 12 inches minimum.

D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:

1. Each paving fabric, 12 by 12 inches minimum.
2. Each type and color of preformed traffic-calming device.
3. Each pattern and color of imprinted asphalt and precut marking material.

E. Qualification Data: For qualified manufacturer and Installer.

F. Material Certificates: For each paving material, from manufacturer.

G. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located

B. Installer Qualifications: Imprinted-asphalt manufacturer's authorized installer who is trained and approved for installation of imprinted asphalt required for this Project.

C. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

D. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Standard Specifications for Materials and Construction of The Maryland State Highway Administration for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

E. Preinstallation Conference: Conduct conference at Project site .

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review condition of subgrade and preparatory work.
c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials and 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: In accordance with MDSHA Standards and Specifications.

C. Fine Aggregate: In accordance with MDSHA Standards and Specifications.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: In accordance with MDSHA Standards and Specifications.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: In accordance with MDSHA Standards and Specifications.

B. Asphalt Cement: In accordance with MDSHA Standards and Specifications.

C. Prime Coat: Asphalt emulsion prime coat complying with Maryland DOT requirements.

D. Tack Coat: In accordance with MDSHA Standards and Specifications.

E. Water: Potable.

F. Undersealing Asphalt: ASTM D 3141, pumping consistency.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Sand: In accordance with MDSHA Standards and Specifications.

C. Joint Sealant: In accordance with MDSHA Standards and Specifications.

D. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type F; colors complying with FS TT-P-1952.

1. Color: As indicated.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: 19mm Superpave
3. Surface Course: 9.5mm Superpave

B. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.

3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch

2. Surface Course: 1/8 inch
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials, July 2008 and all approved addenda, except Method of Measurement and Basis of Payment.

1.2 SUMMARY

A. Section Includes:

1. Driveways.
2. Curbs and gutters.
3. Walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

E. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.

7. Bonding agent or epoxy adhesive.
8. Joint fillers.

F. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

G. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

C. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

D. ACI Publications: Comply with ACI 301 unless otherwise indicated.

E. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete paving subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials and 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

D. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

F. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

H. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

I. Plain-Steel Wire: ASTM A 82/A 82M.

J. Deformed-Steel Wire: ASTM A 496/A 496M.

K. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type II. Supplement with the following:

a. Fly Ash: ASTM C 618, Class C or Class F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IP, portland-pozzolan cement.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source[with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.
b. BASF Construction Chemicals, LLC; Confilm.
c. ChemMasters; Spray-Film.
d. Conspec by Dayton Superior; Aquafilm.
e. Dayton Superior Corporation; Sure Film (J-74).
f. Edoco by Dayton Superior; BurkeFilm.
g. Euclid Chemical Company (The), an RPM company; Eucobar.
h. Kaufman Products, Inc.; VaporAid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation, Inc.; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.

E. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; A-H Curing Compound #2 WP WB.
b. ChemMasters; Safe-Cure 2000.
c. Conspec by Dayton Superior; DSSCC White Resin Cure.
d. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).
e. Edoco by Dayton Superior; Resin Emulsion Cure V.O.C. (Type II).
f. Euclid Chemical Company (The), an RPM company; Kurez VOX White Pigmented.
g. Kaufman Products, Inc.; Thinfilm 450.
h. Lambert Corporation; AQUA KURE - WHITE.
i. L&M Construction Chemicals, Inc.; L&M CURE R-2
j. Meadows, W. R., Inc.; 1100-WHITE SERIES.
k. SpecChem, LLC; PaveCure Rez White.
l. Symons by Dayton Superior; Resi-Chem White.
m. Vexcon Chemicals Inc.; Certi-Vex Enviocure White 100.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, non-load bearing and Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): MDSHA Mix 3 per Section 901A

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture, high-range, water-reducing admixture, high-range, water-reducing and retarding admixture, plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals and as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms[, steel reinforcement,] and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect/Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect/Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect/Engineer.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect/Engineer.

B. Drill test cores, where directed by Architect/Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321400 – UNIT PAVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following.

1. Concrete pavers set on bituminous setting beds.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for excavation and compacted subgrade.
2. Division 2 Section "Hot-Mix Asphalt Paving" for asphalt base under unit pavers.
3. Division 2 Section "Cement Concrete Pavement" for concrete base under unit pavers and edge restraint.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Pavers.
2. Bituminous setting materials.

B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

C. Samples for Initial Selection: For the following:

1. Each type of unit paver indicated.

D. Samples for Verification:

1. Full-size units of each type of unit paver indicated.
2. Joint materials.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

A. Concrete Pavers: Solid paving units, made from normal-weight concrete with a compressive strength not less than 5000 psi, water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.

Pedestrian Areas:
1. Products: Hanover Architectural Products – Hanover Custom Prest Brick.
2. Thickness: 2-3/8 inches.
3. Face Size and Shape: 4” x 8”.
4. Color: 4 custom colors to be selected by the landscape architect, architect and/or Owner
5. Finish: Tudor

Vehicular Areas:

1. Products: Hanover Architectural Products – Hanover Custom Prest Brick.
2. Thickness: 3 inches.
3. Face Size and Shape: 4” x 8”.
4. Color: 4 custom colors to be selected by the landscape architect, architect and/or Owner.
5. Finish: Tudor

2.2 AGGREGATE AND CONCRETE BASE MATERIALS

A. See concrete paving specification.

2.3 BITUMINOUS SETTING-BED MATERIALS

A. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.

C. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.

D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

E. Sand for Joints: ASTM C144, Fine, sharp, washed, natural sand with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

1. Provide sand of color needed to produce required joint color as selected by Landscape Architect at time of paver selection.

2.4 BITUMINOUS SETTING-BED MIX

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate, unless otherwise indicated. Heat mixture to 300 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair setting bed bond, including curing and sealing compounds, form oil, and laitance.

B. Clean concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Division 2 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

D. Joint Pattern: As indicated on drawings.

E. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.

F. Expansion and Control Joints: Concrete base for pavers shall have expansion joints on a spacing not to exceed 20’ x 20’ and at vertical objects such as building walls, columns, curbs, etc.. Expansion material shall not extend up through the paver course.

G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

3.4 BITUMINOUS SETTING-BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating 3/4-inch- deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F. Strike setting bed smooth, firm, even, and not less than 3/4 inch thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of 3/4 inch. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F.

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.5 REPAIRING AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, cracked, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove dirt and debris from exposed paver surfaces; wash and scrub clean.

END OF SECTION 321400

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Preparation of planting soil
2. Fertilizing and liming
3. Seeding.
4. Sodding.
5. Maintenance.

B. Related Sections include the following

1. Grading
2. Stripping and stockpiling of topsoil

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or existing on-site surface topsoil modified to become planting soil by mixing with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

A. Test results of planting soil analysis. The installer shall furnish an agricultural soil analysis, for each planting soil source, conducted by a qualified soil-testing laboratory stating percentages of organic matter, gradation of sand, silt , and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plan nutrient content.

B. The Analysis shall report the suitability of planting soil for turf and meadow growth; and state the recommended quantities of nitrogen, phosphorous potash, lime and other soil amendments to be added to produce a satisfactory planting soil.

C. Product data and labels for fertilizer, wood fiber, mulch and binder herbicides and pesticides.

D. Seed tags and source of supply.

E. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, percentage of purity, germination, and weed seed, the year of production, date of packaging and source including name and telephone number of supplier.

F. Product Certificates for soil amendments and fertilizers, signed by product manufacturer.

G. Qualification Data for landscape Installer.

H. Planting Schedule indicating anticipated planting dates for each type of planting.

I. Maintenance Instructions recommending procedures to be established by Owner for maintenance of lawns and meadows during a calendar year. Submit before expiration of required maintenance periods.

1.5 PLANTING SEASON

A. Sod shall not be placed during the period of June 1st to August 15th unless provisions are made for watering. Frozen sod shall not be placed nor shall sod be placed on frozen soil.

B. Meadow Mix shall not be seeded during the period of June 15th to December 15th. When seeding between December 15th and April 1st the seeding rate shall be increased by 25%.

C. Turf seeding will be permitted between April 1-May 15 and September 1-Oct. 15.

D. No seeding shall be allowed on frozen ground or when snow covers the ground.

E. Any deviation from this time schedule shall require written consent from the Owner, or landscape architect.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape contractor whose work has resulted in successful turf and meadow establishment. Installer shall have not less than 5 years documented successful experience with installation of work similar to work of this project and be a member of the Landscape Contractors Association of MD.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the Maryland Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish agricultural soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for lawn and meadow growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Seed shall not be exposed to moisture or extremes in heat or cold prior to installation.

C. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Fertilizer shall be a complete commercial fertilizer of at least 25% organic base containing Nitrogen, Phosphorus, and Potash, uniform in composition, free flowing and suitable for application with the approved equipment, of proportions necessary to eliminate any deficiencies of the planting soil identified by the Analysis.

B. Fertilizer shall be delivered to the site fully labeled according to applicable state fertilizer laws and shall bear the name, trade name, trademark and warranty of the provider.

2.2 SEED

A. All seed and labeling must fully comply with the Maryland Seed Law and these specifications.

B. Seed shall be packed 50 lbs. net weight in new, clean, poly woven bags, tightly woven to prevent leaking and contamination.

C. All seed must be state certified and blended under the supervision of the Maryland Department of Agriculture (MDA), Turf and Seed Section.

D. All seed and labeling must fully comply with the Maryland State Department of Agriculture (MDA) Turf & Seed Section.

E. Each bag shall contain proper label and certification tag.

F. Turf seed mix shall be a blend of three Turf-Type Tall Fescues selected from the latest University of Maryland Agronomy Mimeo #77, "Turfgrass Cultivar Recommendations for Certified Sod and Professional Seed Mixtures in Maryland".Two varieties are to be selected from Category I and one variety from Category II.

1. All seed must meet the following minimum specifications:

a. Minimum Purity - 98%
b. Minimum Germination - 85%
c. Maximum Other Crop* - 0.1%. Must be free of ryegrass, timothy, orchardgrass, bentgrass, Canada bluegrass, clover, or any other contaminant which shall be unsightly or hard to control.
d. Maximum Weed Seed** - 0.1%. Must be free of dock, cheat, chess, chickweed, crabgrass, plantain and black medic.
e. Noxious Weed Seed - NONE. Must be free of all seed listed by Maryland as noxious.

2.3 SOD

A. Sod shall be cut as required, delivered to the site, and transplanted within a period of 24 hours.

B. Shall be certified Tall Type Fescue, Class A, nursery grown sod minimum 1" thick with a strong, fibrous root system and moist when cut at the sod farm.

C. It shall be free of noxious weeds and seeds, stones, and burned or bare spots.

D. The sod shall have been maintained with a regular cutting schedule and at a minimum height of three (3") inches.

E. Sod to be installed on predominantly sunny sites shall consist of a mixture of three Tall Fescue varieties as described above and matching the seed mix.

2.4 LIME

A. Lime shall be ground or pulverized limestone which contains at least 50% total oxides (calcium oxide plus magnesium oxide). Limestone shall be ground to such a fineness that at least 50% will pass through a 100-mesh sieve and 98-100% will pass through a 20-mesh sieve.

B. Granular of pelletized lime may be used, but must conform to the above specifications prior to being granulated or pelletized.

2.5 WOOD CELLULOSE FIBER

A. Conwed hydro mulch or similar approved material.

B. Stain may be substituted provided a binding agent is incorporated into the slurry mix.

2.6 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

2.7 ORGANIC SOIL AMENDMENTS

A. Compost: By an approved supplier such as “Com-pro” or “Leaf-Gro”. Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings. Use compost from approved supplier.

2.8 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.9 PLANTING SOIL

A. Planting soil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1. Planting soil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

b. All topsoil or planting soil brought to the site shall be tested separately for each source by an independent Soil Testing Laboratory recognized by the State Department of Agriculture, as described in section 1.6,C, above. Amendments shall be added as per the soil test recommendations.

2.10 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:

1. Class: Class O, with a minimum 95 percent passing through No. 8 sieve and a minimum 55 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.

C. Perlite: Horticultural perlite, soil amendment grade.

D. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

E. Sand: Clean, washed, natural or manufactured, free of toxic materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Installer shall examine areas to receive turf and meadows for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. The Installer shall protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by seeding operations.

B. The Installer shall provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AND MEADOW PREPARATION

A. The Installer shall limit soil preparation to areas to be seeded.

B. Once subgrades have been established the Installer shall loosen subgrade to a minimum depth of 4 inches, remove stones, larger than 1 inch in any dimension, sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread approximately 2 inches of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread additional 2 inches of planting soil and mix thoroughly into the 4 inches below.
2. Apply soil amendments and fertilizer, as recommended by agricultural analysis, on surface, and thoroughly blend into planting soil. If required by testing agency, mix lime with planting soil before mixing fertilizer.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within 48 hours.
    b. Spread planting soil mix to achieve a depth of 4 inches after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
    c. Allow for thickness of established turf when establishing finished grades.
    d. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Where turf or meadows are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations the Installer shall prepare surface soil as follows:

1. Apply glyphosate per manufacturer’s recommendations to existing grass, herbaceous vegetation, and turf. Wait two weeks for herbicide to control vegetation. A minimum of 95% control of existing vegetation shall be achieved, if control is not achieved reapply herbicide and wait an additional two weeks.
2. Remove dead vegetation; plants and roots.
3. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers according to planting soil test analysis and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous uniform mixture.

4. Remove stones and soil clods larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
5. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. The Installer shall grade seeding areas to a smooth, uniform plane with a loose uniformly fine surface texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted within 48 hours.

E. The Installer shall moisten prepared seeding areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. The Installer shall restore areas if eroded or otherwise disturbed after finish grading and before seeding.

G. Immediately before sowing the seed the Installer shall rework the surface until it is a fine pulverized seed bed.

3.4 LAYING SOD

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod closely knit together with no open joints visible, and pieces not overlapped. Stagger joints in successive rows. Lay smooth and flush with adjoining grass areas, areas to be seeded, paving and top surface of curbs.

C. On slopes greater than 3:1 (three feet horizontal to one foot vertical) lay sod perpendicular to slope and secure each row with sod staples spaced two (2) feet on center maximum. Drive sod staples level with the soil portion of the sod.

D. Immediately water sodded areas after installation. Water in sufficient amounts to saturate sod and upper 4 inches of soil.

E. After sod and soil have dried enough to prevent damage, roll sodded areas to insure good bond between sod and soil and remove any minor depressions and irregularities. Rolling equipment weight should not be over 250 lbs. or less than 150 lbs.

3.5 SEEDING

A. The Installer shall evenly sown seed at the following rates:

1. Turf Grass: 6 pounds/1000sf (260 #/AC)
2. Meadow Mix: 15-18 pounds/ AC

B. The Installer shall lightly work seed into the surface using a mechanical seeder.

C. The Installer shall apply wood cellulose fiber at the rate of 1400 lbs/ac. or loosely apply a layer of clean straw at the rate of two (2) tons per acre, in conjunction with tack binder. If mulch is displaced before grass is 1 1/2" high, it shall be reapplied at no additional cost to the Owner.

D. On slopes greater than 4:1 and in the event the seeding takes place during dry periods, the Contractor shall use wood cellulose fiber with an approved binder material instead of straw.

3.6 CLEAN UP

A. During installation the Installer shall "broom" clean all sidewalks and other paved areas at the end of each workday. Sidewalks and other paved areas shall be swept or washed down as directed by the Owner.

B. Following completion of operations the Installer shall remove all debris, excess soil and trash from the site and wash all paved areas.

3.7 MAINTENANCE

A. The Contractor shall maintain turf and meadow areas until acceptance. Maintenance shall include but not be limited to watering, fertilizing, weeding, rolling, regrading and replanting as required to establish a smooth, dense, permanent Class "A" turf or meadow of grasses which have rooted and grown for not less than 30 days.

B. The Owner or Owner's representative will not accept any portion(s) of the turf or the meadows separately, and will not accept turf or meadows which contain thin spots, bare spots exceeding 3 by 3 inches, eroded areas, or excessive weeds.

C. The Contractor shall mow all turf areas to a height of 3” removing no more than 50% of the total leaf height at one time until the owner has accepted the turf. The owner may delay acceptance until 90% coverage has been achieved.

D. After acceptance, the Owner will maintain all turf and meadow areas.

END OF SECTION 329200

SECTION 329300 – EXTERIOR PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Trees.
   2. Shrubs.
   3. Groundcovers.

1.3 REFERENCES

A. Standards: Comply with applicable recommendations of the following:.
   1. "Standardized Plant Names", American Joint Committee on Horticultural Nomenclature.
   2. "American Standard for Nursery Stock", American Association of Nurserymen.

1.4 DEFINITIONS

A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

B. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.

C. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.

D. Final Acceptance: The event when the warranty and maintenance periods are over, and the contractor has complied with all provisions of the contract documents, and the County Department of Parks and Recreation representative grants the contractor release from further contractual obligations as they pertain to the provisions specified in this Section.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Initial Acceptance: The event when the work is substantially completed and approved by a representative of the Owner, and establishes the date for the Warranty and Maintenance periods to commence.

G. Maintenance Turnover: The date of the maintenance transition for all plant material installed as part of this contract, over to the Owner with knowledge and agreement. From that date the Owner assumes responsibility for the maintenance of all plant material.

H. Partial Acceptance: The event when the work is substantially completed on a portion of the Project and the Contractor will be delayed one planting season from completing the remainder of the work. The Owner or Landscape Architect may grant a partial acceptance for the approved portion of the work that qualifies, and that date will establish the date for the warranty and maintenance period to commence only on that approved completed portion. Granting of partial acceptance shall also extend the Warranty period accordingly.

I. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

J. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.
1. Commercial fertilizers,
2. Chemical additives,
3. Organics,
4. Lime,
5. Iron Sulfate,
6. Filter cloth/Soil separator,

B. Material Samples for Verification: Submit one pound samples, packaged in labeled plastic bags, to the Landscape Architect for examination and approval prior to any landscape operations.
1. Mulches,
2. On-site soils,
3. Imported soils,
4. Organics,
5. Soil mixes.

C. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:
1. Manufacturer's certified analysis for standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

D. Material Test Reports: Agricultural analysis for existing surface soil and imported topsoil with recommendations for any proposed amendments.

E. Planting Materials: Note, plant quantities shall be as shown on the Landscape drawings. Submit in writing the following:
1. The specific variety, quantity and size of each plant to be provided.
2. The Nurseries from where plant material is to be obtained.
3. Tentative schedules for tree selection, approvals and installation.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

G. Soil Samples: Obtain the following soil samples where applicable.
   1. Imported topsoil: Topsoil is to be certified for suitability and conformance with the soil pH, texture, and nutrient content best matching the planting requirements for the proposed plant materials based on an agricultural analysis to be performed by contractor.
   2. On-site topsoil: topsoil from on-site stockpiles is to be certified for suitability based on an agricultural analysis to be performed by contractor
   3. Organics: Provide certified analysis and pH levels from suppliers.
   4. Soil Mixes: Submit soil mixes for analysis as requested by the Landscape Architect.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer with a minimum of five years experience whose work has resulted in successful establishment of exterior plants for a project of equal or similar size and complexity.
   1. Installer shall be a member in good standing of the Maryland Landscape Contractor's Association or other appropriate organization. Submit qualifications for approval.
   2. Installer's Field Supervision: Installer shall be required to maintain a full-time supervisor on Project site with a minimum of five years successful experience at installing exterior plant materials.

B. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
   1. Report suitability of topsoil for plant growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

C. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

D. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above ground for trees up to 4-inch caliper size, and 12 inches above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

E. Observation: Landscape Architect may observe shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Review of photographs may be acceptable based on coordination with Landscape Architect. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
   1. Notify Landscape Architect of sources of planting materials 14 days in advance of delivery to site.

F. Plant substitutions – Pre-Bid:
   1. It is the landscape contractor's responsibility to make every reasonable effort to find the plant material specified on the plans.
   2. The Contractor is also responsible for qualifying his/her bid to document any plant suitability or availability problems.
   3. The Contractor may offer substitutions to the Owner and Landscape Architect for consideration if there are legitimate availability problems.

4. The Contractor may also offer substitutions if there are known diseases or insect resistant species that can be substituted for a pest prone plant.
5. The Contractor shall submit a Base Bid as per plans and specifications, plus any price changes or clarifications for all recommended plant substitutions.

G. Plant substitutions – Post Bid, Pre-Installation
1. It is the intent to reduce or eliminate post-bid substitutions.
2. Any substitutions of plant materials will not be permitted unless authorized in writing by the Owner of Landscape Architect.
3. If proof is submitted that any plant accepted during the bidding process is not attainable, a proposal will be considered for use of a nearest equivalent size or variety, with a corresponding adjustment on Contract price as deemed necessary.
4. These provisions do not relieve the Contractor of responsibility for obtaining materials in advance if special growing conditions or other arrangements can be made in order to provide the required materials.

H. Preliminary plant acceptance:
1. The Owner and/or Landscape Architect reserve the right to tag the trees at their place of growth in a Nursery within 3 hours drive of Montgomery County. Any stock acquired from nurseries of a greater distance will be reviewed from at least two pictures of different sides including some indication of scale. All plant material is to be obtained from a source within 300 miles of the site.
2. The Owner or Landscape Architect may view all other plants at their place of growth or upon delivery.
3. For distant material, photographs may be submitted in lieu of an on site inspection or for preliminary reviews prior to site inspection.
4. The Contractor shall send the Owner/Landscape Architect a written request at least ten calendar days prior to digging for plant inspection at their place of growth.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug.

B. Do not prune trees and shrubs before delivery, except as approved by the Owner or Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.

C. Handle planting stock by root ball. Do not bind plants with wire or rope

D. Plants damaged in transit, storage or handling may be rejected at the sole discretion of the Owner/Landscape Architect. The Contractor shall note that consideration for plant material rejection may be cosmetic such as broken branches or scratched trunks.

E. The Contractor shall coordinate the temporary storage of plant material with the General Contractor or other trades as required to keep the plants away from the on-going construction. If plants cannot be planted immediately upon delivery to the site, they are to be kept in the shade, protected with soil, damp mulch, or other acceptable material and kept well watered. Plants are not to be stored on the site longer than three days following delivery.

F. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants in shade, protect from weather and mechanical damage, and keep roots moist.
   1. Set balled stock on ground and cover ball with mulch, soil, or other acceptable material.
   2. Do not remove container-grown stock from containers before time of planting.
   3. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.8 COORDINATION

A. Planting Restrictions: Planting shall be conducted during the period of April 1st through June 15th or September 1st through December 1st.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns, unless otherwise acceptable to Owner/Landscape Architect.
   1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.9 WARRANTY

A. All plants shall be guaranteed to remain alive and healthy for one full year after Initial Acceptance.

B. Inspection and Initial Acceptance:
   1. Contractor shall notify the Owner/Landscape Architect, in writing, of project completion and shall request an inspection.
   2. Inspection shall be made by the Owner/Landscape Architect and the Contractor within two weeks of written notification from the Contractor.
   3. If the plant material and workmanship are satisfactory, the Owner/Landscape Architect will give written notice to this effect. This will constitute approved Initial Acceptance of the project and the warranty and maintenance periods will commence from this date.
   4. Care of the plant material shall begin at this point and shall continue through the life of the contract. During this time period, the Contractor shall do all work necessary to establish and keep the plants alive and healthy.

C. Final Acceptance:
   1. The Contractor will coordinate a final inspection with the Owner/Landscape Architect at the end of the one year period. It will be the Contractor's responsibility to notify the Owner/Landscape Architect within two weeks of the anticipated meeting.
   2. Any plant material that is 25% dead or more shall be considered dead and must be replaced at no additional charge. A tree shall be considered dead when the main leader has died back, or there is 25% of the crown dead.
   3. Deciduous material will be guaranteed to break dormancy if planted in dormant season.

D. Replacements and Conditions:
   1. Remove dead plant material immediately and replace immediately or during the next appropriate planting season.
   2. The contractor will be responsible for a one-time planting replacement.
   3. Replacements will be of the same size and species as the original.

4. The Contractor will not be responsible for plant material that has been damaged due to vandalism, fire, relocation, or other activities and conditions beyond the Contractor's control.

1.10 MAINTENANCE

A. Maintenance shall begin immediately after the entire project has been approved by the Owner/Landscape Architect for Initial Acceptance. The landscape Contractor shall provide all materials, labor and equipment to complete all landscape maintenance work for the one year warranty period.

B. Standards:
1. All landscape maintenance services shall be performed by trained personnel using current, acceptable horticultural practices.
2. All work shall be performed in a manner which maintains the original intent of the landscape design.
3. All chemical applications shall be performed in accordance with the current county, state and federal laws, utilizing EPA- approved materials and methods of applications. These applications shall be performed under the supervision of a Licensed Certified applicator.

C. Workmanship:
1. During landscape maintenance operations, all areas shall be kept neat and clean. Precautions shall be taken to avoid damages to existing structures. All work shall be performed in a safe manner to the operators, the occupants and pedestrians.
2. Upon completion of maintenance operations, all debris and waste materials shall be cleaned up and removed from the site, unless provisions have been granted by the owner to utilize on-site trash receptacles.
3. Any damage to the site caused by the landscape Contractor shall be repaired by the landscape Contractor without charge to the owner.

D. Trees, Shrubs and Groundcover:
1. Pruning: All ornamental trees, shrubs and groundcover shall be pruned as appropriate to remove dead or damaged branches, develop the natural form of the plant or to create the effect intended by the landscape architect.
2. Weeding: All beds shall be weeded on a continuous basis throughout the growing season to maintain a neat appearance at all times.
3. Insect and Disease Control: The landscape Contractor shall be responsible for monitoring the site conditions on each visit to determine if any insect or disease problems exist. Immediate measures shall be taken to eliminate any disease or infestation problems.
4. Trash Removal: The landscape Contractor shall remove trash from all plant beds with each visit.
5. Winter Clean up: The project shall receive a general clean up during each of the winter months (January, February and March) to include: removing trash and unwanted debris, turning mulch where necessary, and inspection of grounds.
6. Watering: The landscape Contractor shall be responsible for watering all plant material as necessary throughout the growing season.
7. Miscellaneous:
   a. Mulch areas of all planting beds and tree pits shall be maintained at a 2" minimum level. Plants shall be remulched at the end of the maintenance period, prior to turning over the project to the County.
   b. Plants shall be reset to proper grade or upright position as necessary. Stakes and guys shall be adjusted as necessary during the maintenance period and removed at the end.

c. The Contractor shall prepare maintenance guidelines for use by the owner.
d. All stakes and guys shall be removed by the Contractor at the end of the one-year warranty period.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
   1. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots and rootballs.
   2. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name. Tags are to remain on until initial acceptance is granted.
   3. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 MULTI-STEM TREES

A. Multi-stem Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
   1. Stem Form: Clump.
   2. Provide balled and burlapped trees.

2.3 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.
   1. Provide balled and burlapped and container-grown shrubs.

2.4 CONIFEROUS AND BROADLEAF EVERGREENS

A. Form and Size: Normal-quality, well-balanced, coniferous and broad leaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.
   1. Provide balled and burlapped trees.

2.5 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.6 PERENNIALS AND BULBS

A. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed.

B. Bulbs: Provide healthy topsize bulbs from a commercial nursery, of species and variety shown or listed.

2.7 TOPSOIL

A. Topsoil: New topsoil shall be good friable, natural loam topsoil, containing no subsoil material, free of sticks, stones, roots, weeds, debris or other extraneous matter, and shall have an acidity range of pH 5.0 to pH 7.0. The Contractor shall provide certification test results that the topsoil does not include chemicals deleterious to plant growth, e.g: Atrozine.

2.8 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
Class: Class O, with a minimum 95 percent passing through No. 8 sieve and a minimum 55 percent passing through No. 60 sieve
1. Provide lime in form of dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.

C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

D. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.9 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Peat: Finely divided or granular texture, with a pH range of 4.5 to 6.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water absorbing capacity of 1100 to 2000 percent..

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.10 FERTILIZER

A. Fertilizer: FS O –F-241, Type I, Grade A; Granular packet, or pellet form with 35-80% of the total nitrogen in a slow release form with fifty percent of the elements derived from organic sources. Sulfur coated and IBDU fertilizers are not permitted.
   1. Trees – Fertilizer shall be complete fertilizer with a minimum analysis of 10% nitrogen, 6% phosphorous and 4% potassium

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from the Maryland Department of Agriculture.
   2. In support of the state of Maryland's initiative to minimize nutrient run-off into the bay, only use fertilizers and other soil amendments as recommended by the agricultural soil analysis as necessary for healthy plant growth.

2.11 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, dark brown in color and consisting of one of the following:
   1. Type: Double-shredded hardwood bark

2.12 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to the manufacturer's written instructions.

2.13 PLANTING SOIL MIX

A. Planting Soil Mix: Mix topsoil and backfill for tree pits with the following soil amendments in the following quantities:
   1. Soil mix shall be 50% topsoil, 25% sand (as needed based on soil conditions), and 25% leaf mulch organic matter.
   2. Add fertilizers in quantities as recommended by soil test recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple exterior plantings. Stake locations, outline areas, adjust locations when requested, and obtain acceptance of layout from the Owner or Landscape Architect prior to planting. Make adjustments as required.

D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
   1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

3.3 PLANTING BED ESTABLISHMENT

A. Loosen subgrade of planting beds to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Spread 6 inches of topsoil, apply soil amendments and fertilizer (as determined by the soil report) on surface, and thoroughly blend to create the planting soil mix.
   2. Rototill topsoil and amendments into top 12 inches of the soil.
   3. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
   4. Mix lime (as determined by the soil report) with dry soil before mixing fertilizer.

B. Spread planting soil mix to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

C. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

D. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.4 TREE AND SHRUB EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
   1. Excavate approximately two times as wide as ball diameter for balled and burlapped and container-grown stock.

B. Subsoil removed from excavations may be used as backfill and is to be amended as noted in planting soil mix.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch diameter holes, one (1) per tree pit or minimum 10' on-center within planting bed area, into free-draining strata or to a depth of 3 feet, whichever is less, and backfill with free-draining material.

D. Fill excavations with water and allow to percolate away before positioning trees and shrubs. Excavations shall drain completely within (12) hours of filling.

E. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.
1. Non-percolating soils: Drill 6-inch diameter holes, one (1) per tree pit or minimum 10' on-center within planting bed area, into free-draining strata or to a depth of 3 feet, whichever is less, and backfill with free-draining material.

3.5 TREE AND SHRUB PLANTING

A. Set balled and burlapped root balls plumb and in center of pit or trench with top of root ball at adjacent finish grades.
1. Cut and remove wire baskets from top one third of root balls. No cut wires from baskets should extend above the finished grade. Bend remaining lower sections of wire basket away from rootball. Remove burlap from top one third of root ball. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

B. Set container grown plant material stock plumb and in center of pit or trench with top of root ball at adjacent finish grades.
1. Carefully remove root ball from container without damaging root ball or plant.
2. If root bound, carefully scarify the root ball on three sides and loosen root mass taking care to retain larger root leaders.
3. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

C. Organic Mulching: Apply 2 inch thickness of organic mulch continuously throughout planting beds. Do not place mulch within 4 inches of trunks or stems. Do not pile mulch up to create a large mound.

3.6 TREE AND SHRUB PRUNING

A. Prune trees and shrubs according to standard horticultural practice. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured or dead branches from trees.

3.7 GUYING AND STAKING

A. Anchoring and Tying: Stake and support trees as shown on drawings with anchor system per manufacturer's recommendation. Set vertical anchors and space to avoid penetrating root balls or root masses. Allow enough slack to avoid rigid restraint of tree.

3.8 GROUND COVER PLANTING

A. Set out and space ground cover and plants as indicated.

B. Dig holes large enough to allow spreading of roots, and backfill with planting soil mix.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly with an open end nozzle sprayer immediately after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING BED MULCHING

A. Mulch backfilled surfaces of planting beds and other areas indicated.
   1. Organic Mulch: Apply 2-inch thickness of organic mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems.
   2. Mulch shall be placed the day of planting.

3.10 CLEANUP AND PROTECTION

A. During exterior planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

3.11 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 329300

SECTION 330800 – UTILITIES COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Systems and equipment testing and start-up

B. Validation of proper and thorough installation of Utilities

C. Prefunctional performance testing of equipment and systems

D. Documentation of tests, procedures, and installations

E. Coordination of Training Events

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner's operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.

B. Commissioning Authority (CA) is retained by the Owner shall work with the Contractor and the Design Engineer to direct and oversee the Cx process and perform functional performance testing.

C. This Section outlines the Cx procedures specific to the underground utilities. While most of these systems may be specified in other technical specification sections, they are listed here to ensure that the installation, start-up, documentation, testing and training for these systems will be completed per the Commissioning process described herein. Requirements common to all Sections are specified in Sections 019113 and 019114 and the Cx Plan.

1.3 SCOPE

A. The following are included in the Scope of Commissioning on this project:

1. Utilities including water, wells, sanitary, storm drainage, fuel distribution, hydronic and steam energy, electrical and communications utilities, systems, assemblies, equipment and components. Systems to be commissioned shall include but not be limited to the following ():

a. Domestic water
b. Chilled and Hot Water
c. Natural Gas
d. Fuel Oil
e. Sanitary Sewer
f. Storm Drainage

g. Electrical Power
h. Security Systems
i. Telecommunications

1.4 RELATED WORK AND DOCUMENTS

A. Section 019113 – General Commissioning Requirements: details the Cx requirements common across all divisions

B. Section 019114 – Functional Testing Procedures: Outlines the generic functional testing procedures required.

C. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 019113

1.6 REFERENCE STANDARDS

A. ASHRAE Guideline 1-1996, "Guideline for Commissioning HVAC Systems"

B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”

C. NEBB – Procedure Standards for Building Systems Commissioning

1.7 DOCUMENTATION

A. In addition to the documentation required in Section 019113, Contractor shall provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format.
2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in pdf electronic format.

1.8 CONTRACTOR RESPONSIBILITIES

A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113.

B. Construction Phase

1. Provide skilled technicians qualified to perform the work required.
2. Provide factory-trained and authorized technicians where required by the Contract Documents.
3. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.
4. Start-up, and test/adjust/balance systems and equipment as detailed throughout Contract Documents.
5. Record Start-up Procedures on start-up procedure forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.

C. Acceptance Phase

1. Assist CA in functional performance testing. Assistance will generally include the following:

   a. Provide any specialized instrumentation necessary for functional performance testing;
   b. Manipulate BAS and other control systems to facilitate functional performance testing.

D. Warranty Phase

1. Maintain record documentation of any configurations, set ups, parameters etc, that change throughout the period.
2. Respond to Warranty issues as required by Division 1 and the General Conditions.

1.9 TRAINING

A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 019113 and the individual Specifications.

PART 2 - PRODUCTS

2.1 WEB-BASED COMMISSIONING PORTAL

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal ('Portal') to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 019113 the individual Specifications for additional information and requirements for using the Portal.

PART 3 - EXECUTION

3.1 PROCEDURES COMMON TO ALL SYSTEMS

A. The following start up verifications/procedures are common to all systems

B. Checkout shall proceed from devices to the components to the systems.

C. Verify labeling is affixed per spec and visible

D. Verify prerequisite procedures are done.

E. Inspect for damage and ensure none is present.

F. Verify system is applied per the manufacturer's recommendations

G. Verify system start up has been per the manufacturer's recommendations

H. Verify that access is provided for inspection, operation and repair

I. Verify that access is provided for replacement of the equipment

J. Verify the record drawings, submittal data and O&M documentation accurately reflect the installed systems

K. Verify all gages and test ports are provided as required by contract documents and manufacturer's recommendations

L. Verify all recorded nameplate data is accurate

M. Installation is done to ensure safe operation and maintenance.

N. Verify specified replacement material/attic stock has been provided as required by the Construction Documents

O. Verify all rotating parts are properly lubricated

P. Verify all monitoring and ensure all alarms are active and set per Owner's requirements

Q. Complete all nameplate data and confirm ratings conform with the design documents

END OF SECTION 330800

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Expansion joints and deflection fittings.
4. Cleanouts.
5. Drains.
6. Encasement for piping.
7. Manholes.
8. Channel drainage systems.
9. Catch basins.
10. Stormwater inlets.
11. Stormwater detention structures.
12. Pipe outlets.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

E. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect/Engineer and College's Representative no fewer than 14 days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect/Engineer's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.2 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, T-1wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.3 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.

1. Bell-and-spigot ends and gasketed joints with ASTM C 443, rubber gaskets
2. Class IV, Wall B.

B. Reinforced-Concrete Low Head Pressure Sewer Pipe and Fittings: ASTM C 361.

1. Tongue-and-groove ends and gasketed joints with ASTM C361, rubber gaskets
2. Class C-25

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
3. Top-Loading Classification(s): Light Duty, Medium Duty, Heavy Duty, and Extra-Heavy Duty.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:
1. MDSHA or Montgomery County standard as indicated on the plans.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.7 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. MDSHA Standard: MDSHA or Montgomery County standard as indicated on the plans

2.8 PVC SURFACE DRAINAGE INLETS

A. PVC Surface Drainage Inlets: PVC Body with PVC pipe connection stubs manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASMT D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The pipe stock used to manufacture the main body and pipe stubs of the surface drainage inlets shall meet the mechanical property requirements for fabricated fittings as described by ASTM D3034, Standard for Sewer PVC Pipe and Fittings; ASTM F1336, Standard for PVC Gasketed Sewer Fittings.

1. Available Manufacturers:

a. Nyloplast
b. HARCO

2. Top-Loading Classification(s): Heavy duty.

2.9 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to utility standards.

B. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty, according to utility standards.

2.10 STORMWATER DETENTION STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete wall of depth, shape, dimensions, and appurtenances indicated.

2.11 PIPE OUTLETS

A. Head Walls: MDSHA or MCDOT as indicated on the plans.

B. Riprap Basins: Class I

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping with 24-inch minimum cover, unless otherwise indicated.
3. Install PE corrugated sewer piping according to ASTM D 2321.
4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.

2. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
4. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
6. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade unless otherwise indicated.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in roads.

B. Embed drains in 4-inch minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in 4-inch minimum concrete around bottom and sides.

3.6 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.7 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.8 PVC SURFACE DRAINAGE INLETS

A. Install drainage inlets in accordance with the manufacturer's recommendations.

3.9 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.10 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.11 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.12 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.14 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.with water.

3.15 STORMWATER MANAGEMENT AS-BUILT CERTIFICATION

A. The construction of all Stormwater Management facilities shall conform to the approved drawings, Montgomery County Stormwater Management construction standards, MDE Stormwater Design Manual Volumes I&II, and the State of Maryland Highway Standard Specifications. The Contractor is responsible for fully understanding the design and function of the proposed facilities and for constructing facilities in full compliance with design standards. The Contractor shall ensure that all of the required plan checklists are signed by the appropriate individuals at the required stages of construction. The Contractor shall verify all critical inverts and elevations throughout construction to verify conformance with the design and standards. This information shall be provided to the College's Representative and the Architect/Engineer at stages during construction as determined in the field for each individual project. Any adjustments to the construction of the facilities shall be reviewed and approved by the Engineer-In-Charge and MCDPS. Approval of the modifications is required prior to proceeding with construction. The Contractor shall make any corrections and adjustments required to fully provide required design volumes, function, and structural integrity of facilities at no additional cost to the owner. The Contractor shall also verify that all site improvements, flow paths, and drainage areas to each facility are in conformance with the approved design plans. The Contractor is responsible for providing As-Built plans and appropriate support documentation to the College's Representative and the Architect/Engineer. The Contractor shall make any and all repairs and modifications required to obtain As-Built approval by MCDPS and final release of permit at no additional costs to the owner. The Contractor shall be solely responsible for maintenance of all stormwater-related facilities until final acceptance of the facilities by MCDPS, and shall perform full cleanout and/or dredging of facilities prior turn over to the owner.

END OF SECTION 334100

RFP No. 612-005, Part B

Request for Proposal

Bioscience Education Center
Phase 2 – Building, Gateway Signage and Road Construction

Germantown Campus

VOLUME 4

Landmark Gateway Signage Specifications

Montgomery College
Maryland

Date: March 26, 2012
Montgomery College
Office of Central Facilities
40 W. Gude Drive – Suite 200
Rockville, MD 20850

PROJECT MANUAL

For:

RFP No. 612-005 Part B

Montgomery College
Campus Gateway Signage
Germantown, Maryland

Einhorn Yaffee Prescott
Architecture & Engineering, P.C.

1000 Potomac Street NW
Washington, DC 20007
(202) 471 5000

Consultants:

Civil Engineer:
Greenhorne & O'Mara, Inc.
20410 Century Boulevard, Suite 200
Germantown, Maryland 20874
(301) 444-8282

Structural Engineer:
Holbert Apple Associates
3423 Olney-Laytonsville Road, Suite 6
Olney, Maryland 20832
(301) 570-1460

Landscape Architect:
Rhodeside & Harwell, Inc.
320 King Street, Suite 202
Alexandria, VA 33214
(703) 683-7447

Lighting Consultant:
Bruce Dunlop Lighting Design LLC
1134 York Road, Suite 200
Lutherville, MD 21093
(410) 494-1535

March 26, 2012
www.eypae.com

Bioscience Education Center
Phase 2 – Building, Gateway Signage and Road Construction
Germantown Campus

TABLE OF CONTENTS

VOLUME I

INTRODUCTORY INFORMATION

PROPOSAL REQUIREMENTS

CONTRACT REQUIREMENTS

VOLUME 2 – BUILDING CONSTRUCTION

TECHNICAL SPECIFICATION SECTIONS

DIV. 08 DOORS AND WINDOWS

DIV. 09 FINISHES

DIV. 10 SPECIALTIES

VOLUME 3 – BUILDING CONSTRUCTION

DIV. 20 RESERVED

DIV. 21 FIRE SUPPRESSION

DIV. 22 PLUMBING

DIV. 23 HEATING VENTILATION AND AIR CONDITIONING

DIVISION 26 – ELECTRICAL

DIV. 27 COMMUNICATIONS

VOLUME 4 - GATEWAY SIGNAGE

DIVISION 31 – EARTHWORK

DIV. 32 EXTERIOR IMPROVEMENTS

DIV. 33 (NOT USED)

VOLUME 5 – OBSERVATION DRIVE EAST-WEST ROAD AND TRAFFIC CIRCLE

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 02 – EXISTING CONDITIONS

DIVISION 03 – CAST-IN-PLACE CONCRETE

DIVISION 22 - PLUMBING

DIVISION 33 – EARTHWORK

DIVISION 32 – EXTERIOR IMPROVEMENTS

DIVISION 33 – UTILITIES

END OF TABLE OF CONTENTS, PART B

SECTION 01 1000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work by Owner.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and drawing conventions.

B. Related Requirements:

1. Proposal Requirements and Contract Requirements of this Project.

1.2 PROJECT INFORMATION

A. Project Identification: RFP No. 612-005, Part B. Bioscience Education Center, Phase 2 – Building, Gateway Signage and Road Construction, Germantown Campus, Montgomery College, Maryland.

1. Project Location: 20200 Observation Drive, Germantown, MD 20876.

B. Owner: Montgomery Community College, Office of Central Facilities, 40 West Gude Drive – Suite 200, Rockville MD 20850.

1. Owner's Representative: Cynthia Johnston, AIA, Director of Project Management, Montgomery College, Office of Central Facilities, 40 West Gude Drive, Suite 200, Rockville, MD 20850.

C. Architect: EYP Architecture & Engineering, P.C., 1000 Potomac Street NW, Washington, DC 20007, tel. (202) 471-5000. Attn: Mickey Finn, AIA.

D. Architect's Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. Civil Engineer:

Green & O'Mara, Inc.
20410 Century Boulevard, Suite 200
Germantown, MD 20874-1187
Tel. (301) 444-8282

Attn: Kim Currano

2. Landscape Architect:

Rhodeside & Harwell, Inc.
320 King Street, Suite 202
Alexandria, VA 22314
Tel. (703) 683-7447
Attn: Kurt Parker

3. Structural Engineer:

Holbert Apple Associates
3423 Olney Laytonsville Road, Suite 6
Olney, MD 20832
Tel. (301) 570-1460
Attn: David B. Smith, P.E.

4. Lighting Consultant:

Bruce Dunlop Lighting Design, LLC
1134 York Road, Suite 200
Lutherville, Maryland 21093
Tel. (410) 494-1535
Attn: Bruce C. Dunlop, PLDA, IALD, LC, IESNA

E. Other Owner Consultants: The Owner has retained the following design professionals who have prepared designated portions of the Contract Documents for the Project RFP No. 612-005, Part B. Bioscience Education Center, Phase 2 – Building, Gateway Signage and Road Construction:

1. The Lukmire Partnership, 2700 South Quincy Street, Suite 300, Alexandria VA 22306 has prepared the following portions of the Contract Documents:

a. Bioscience Education Center (BE) Phase 2 - Building.

2. A. Morton Thomas & Associates, Inc., 12750 Twinbrook Parkway, Rockville, MD 20852 has prepared the following portions of the Contract Documents:

a. Observation Drive East-West Road and Traffic Circle.

3. BKM, 1423 Darkview Road, Suite 500, Baltimore, MD 21209:

a. Project Quality Control Team Manager and Bioscience Education Center Building Commissioning Authority.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. The Landmark Gateway Signage consists of an assembled “kit of parts” marking the campus entrance located on the north side of the proposed Observation Drive traffic circle. The scope includes a low stone seat wall supporting 3’ high stainless steel “Montgomery College” letters; changeable banner; campus name panel; LED display sign on stone wall; evergreen hedges, and associated lighting and low profile landscaping.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.4 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

1.5 ACCESS TO SITE

A. Refer to Section 000210 – Supplementary Instructions, Part B for site access.

1.6 COORDINATION WITH OCCUPANTS

A. Refer to Section 011000 – Summary, of the Bioscience Education Center Building documents for the requirements of coordination with Owner occupancy.

1.7 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
2. Refer to the Owner’s General Conditions of the Contract for additional work restrictions including, but not limited to the following:

a. On-site work hours.
b. Existing utility interruptions.
c. Noise, vibration, and odors.
d. Montgomery College is a tobacco free institution. Use of tobacco products is prohibited in all indoor and outdoor College-owned facilities and facilities leased and controlled by the College as well as at meetings or conferences sponsored by the College. This use prohibition extends to Contractor’s employees, agents, subcontractors and vendors.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 1000

SECTION 01 5639 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

1.3 DEFINITIONS

A. Caliper: Diameter of a trunk measured by a diameter tape taken at breast height.

B. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

C. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.

D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

C. Qualification Data: For qualified arborist and tree service firm.

D. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

E. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

F. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.5 QUALITY ASSURANCE

A. Arborist Qualifications: Certified Arborist as certified by ISA.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
b. Enforcing requirements for protection zones.
c. Arborist's responsibilities.
d. Field quality control.

1.6 PROJECT CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of weeds, roots, and toxic and other nonsoil materials.

1. Obtain topsoil only from well-drained sites where topsoil is 4 inches (100 mm) deep or more; do not obtain from bogs or marshes.

B. Topsoil: Imported or manufactured topsoil complying with ASTM D 5268.

C. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: Ground or shredded bark.
2. Color: Natural.

D. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements. Previously used materials may be used when approved by Architect.

1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch (50-mm) opening, 0.148-inch- (3.76-mm-) diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- (60-mm-) OD line posts, and 2-7/8-inch- (73-mm-) OD corner and pull posts with 0.177-inch- (4.5-mm-) diameter top tension wire] and 0.177-inch- (4.5-mm-) diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

a. Height: 4 feet (1.2 m).

E. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: As shown on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag tree with appropriate marking tape at each tree trunk at 54 inches (1372 mm) above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3.3 TREE- AND PLANT-PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.
2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Landscape Architect and/or owner. Install one sign spaced approximately every 35 feet on protection-zone fencing, but no fewer than three signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

E. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 312000 "Earth Moving."

B. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.

C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.

D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

A. Prune roots that are affected by temporary and permanent construction. Prune roots as shown on Drawings, and as follows:

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
3. Cover exposed roots with burlap and water regularly.
4. Backfill as soon as possible according to requirements in Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune roots flush with the edge of the protection zone, by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.6 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:

1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
2. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:

    a. Type of Pruning: Cleaning.

3. Cut branches with sharp pruning instruments; do not break or chop.
4. Do not apply pruning paint to wounds.

B. Chip removed branches and dispose of off-site.

3.7 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations. Transition soil edge into existing grade as not to leave a visible edge between existing and new grade elevation. Do not fill against trunk of tree.

3.8 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.9 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed root cutting and tree and shrub repairs.
2. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
4. Perform repairs within 24 hours.
5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Trees: Remove and replace trees indicated to remain that are more than 70% percent dead or in an unhealthy condition or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size and species as those being replaced for each tree that measures 4 inches or smaller in caliper size.
2. Provide two 4-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.

    a. Species: to be selected by the landscape architect

3. Plant and maintain new trees as specified in Section 32 9300 "Exterior Plants."

C. Soil Aeration: Where directed by Landscape Architect, aerate surface soil compacted during construction. Aerate 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augered soil and sand.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 01 5639

SECTION 03 3000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes for:

1. Footings.
2. Walls.

B. Related Sections:

1. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending and placement. Include bar sizes, lengths, material, grade, bar schedules, bent bar diagrams, bar arrangement, splices and laps, and supports for concrete reinforcement.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Curing compounds.

1.5 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Comply with the following sections of ACI 301, unless modified by requirements in the Contract Documents:

1. "General Requirements."
2. "Formwork and Formwork Accessories."
3. "Reinforcement and Reinforcement Supports."
4. "Concrete Mixtures."
5. "Handling, Placing, and Constructing."

C. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

PART 2 - PRODUCTS

2.1 FORMWORK

A. Furnish formwork and formwork accessories according to ACI 301.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Plain-Steel Wire: ASTM A 82, as drawn.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, Type I, Type II, Type I/II or Type III. Supplement with the following:

a. Fly Ash: ASTM C 618, Class C or F.

B. Normal-Weight Aggregate: ASTM C 33, Class 4S, graded 3/4"-inch nominal maximum aggregate size.

C. Water: ASTM C 94/C 94M.

2.4 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.6 CONCRETE MIXTURES

A. Comply with ACI 301 requirements for concrete mixtures.

B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301, as follows:

1. Limit content of fly ash to 20 percent by weight of cement.
2. Minimum Compressive Strength: As noted in the drawings.
3. Maximum Water-Cementitious Materials Ratio: As noted in the drawings.
4. Slump Limit: 5 inches, plus or minus 1 inch typically; 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
5. Air Content: 6 percent, plus or minus 1½ percent.
6. Admixtures: Use admixtures according to manufacturer's written instructions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Locate and install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

3.5 CONCRETE PLACEMENT

A. Comply with ACI 301 for placing concrete.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301. Withhold water at the batch plant if addition of water on site is desired.

C. Consolidate concrete with mechanical vibrating equipment.

3.6 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/2 inch.

1. Apply to concrete surfaces not exposed to public view in final construction.

B. Related Unformed Surfaces: At tops of walls and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.7 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engage a qualified testing and inspection agency to perform field tests and inspections and prepare test reports.

B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture.
2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31.

    a. Cast and laboratory cure two sets of standard cylinder specimens for each composite sample. One set shall consist of two 6"x12" specimens or three 4"x8" specimens.
6. Compressive-Strength Tests: ASTM C 39; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from a set of specimens obtained from the same composite sample and tested at age indicated.

7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
8. Test results shall be reported in writing to Architect, Structural Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.10 REPAIRS

A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION 03 3000

SECTION 04 4313.16 - ADHERED STONE MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stone masonry adhered to concrete backup.

B. Related Requirements:

1. Section 03 3000 "Cast-in-Place Concrete" for installing dovetail slots in concrete for anchoring stone.
2. Section 05 7000 "Decorative Metal" for stainless steel plate for cap of adhered stone masonry walls.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and manufactured product.

B. Samples for Initial Selection: For colored mortar and other items involving color selection.

C. Samples for Verification:

1. For each stone type indicated. Include at least three Samples in each set and show the full range of color and other visual characteristics in completed Work.
2. For each color of mortar required. Label Samples to indicate types and amounts of pigments used.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, supply sources, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.

1. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents contained in mockups unless Architect approves such deviations in writing.

C. Material Test Reports:

1. Stone Test Reports: For each stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous five years.
2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.

B. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for typical exterior seat wall in sizes approximately 48 inches (1200 mm) long by full wall height by full wall thickness, including face and backup wythes, and accessories.

    a. Build mockup of typical wall area as shown on Drawing 1/A200.
    b. Include a sealant-filled joint at least 16 inches (400 mm) long in mockup.
    c. Include decorative stainless steel wall cap and structural support for full length of the mockup. Refer to Section 05 7000 – Decorative Metal.
    d. Include one full-size dimensional letter. Refer to Section 10 4413 – Dimensional Letter Signage.
    e. Include seat cap flashing, stone ties for full-length of mockup specified in this Section.

2. Protect accepted mockups from the elements with weather-resistant membrane.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 07 9200 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.

1.8 FIELD CONDITIONS

A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.

B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.

1. Protect base of walls from rain-splashed mud and mortar splatter using coverings spread on the ground and over the wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.9 COORDINATION

A. Advise installers of other work about specific requirements for placement of flashing and similar items to be built into stone masonry.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from single quarry with resources to provide materials of consistent quality in appearance and physical properties.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.

2.2 LIMESTONE

A. Material Standard: Comply with ASTM C 568.

1. Classification: II Medium Density, except as follows: absorption, 5 percent by weight maximum; density, 150 lb/cu. ft. (2400 kg/cu. m) minimum; compressive strength, 8000 psi (55 MPa) minimum; and modulus of rupture 800 psi (5.5 MPa) minimum.

B. Description: Dolomitic limestone.

C. Varieties and Sources: Subject to compliance with requirements, provide the following:

1. Alverson Limestone; Greystone Quarries, Inc, Evans Mill, NY.
2. Limestone Grade and Color: Select, blue-gray to tan.

2.3 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.

1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix shall produce color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments shall not exceed 10 percent of portland cement by weight.

D. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
b. Lafarge North America Inc.; Eaglebond.

c. Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
d. Mutual Materials Co.; DesignMix Colored Mortar Mix.

E. Aggregate: ASTM C 144 and as follows:

1. For pointing mortar, use aggregate graded with 100 percent passing No. 16(1.18-mm) sieve.

F. Latex Additive: Manufacturer's standard styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Boiardi Products; a QEP company.
b. Bostik, Inc.
c. C-Cure.
d. Custom Building Products.
e. Laticrete International, Inc.
f. MAPEI Corporation.
g. ProSpec; Bonsal American; a division of Oldcastle Architectural Products Group.
h. Southern Grouts & Mortars, Inc.
i. Summitville Tiles, Inc.
j. TEC Specialty Construction Brands, Inc.; an H. B. Fuller company.

G. Water: Potable.

2.4 STONE ANCHORS

A. Corrugated Metal Ties/Buck Anchors: Metal strips not less than 7/8 inch (22 mm) wide by 5 inches (127 mm)with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 12.7 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from 0.062-inch-(1.59-mm-) thick, stainless-steel sheet.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cameron Inc.
b. Heckmann Building Products Inc.
c. Hohmann & Barnard, Inc.
d. Meadow Burke.

B. Dovetail Anchor: Stainless-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

1. Basis-of-Design Product: No. 303 Corrugated Dovetail Tie and No. 305 Dovetail Slot manufactured by Hohmann & Barnard, Inc.

C. Materials: Fabricate anchors from stainless steel, ASTM A 240/A 240M or ASTM A 666, Type 304.

2.5 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing, where flashing is concealed, complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.
2. Provide splice plates at joints of formed, smooth metal flashing.

B. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from urethane or PVC.

2.7 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Diedrich Technologies, Inc.
b. Dominion Restoration Products.
c. EaCo Chem, Inc.
d. Hydrochemical Techniques, Inc.
e. Prosoco, Inc.

2.8 FABRICATION

A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.

1. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

B. Cut stone to produce pieces of thickness, size, and shape indicated, including details on Drawings.

C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.

D. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.

1. Clean sawed backs of stone to remove rust stains and iron particles.

E. Thickness of Stone: Provide thickness indicated

F. Shape stone for type of masonry (pattern) as follows:

1. Sawed-bed, range ashlar strips with uniform course heights as indicated on Drawings and with random lengths (generally longer lengths than rise).

G. Finish exposed stone faces and edges to comply with requirements indicated for finish and to match approved samples and mockups.

1. Finish: Split face.

2.9 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride.
2. Use portland cement-lime mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

B. Preblended, Colored Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Latex-Modified Portland Cement Setting Mortar: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.

D. Cement-Paste Bond Coat: Mix either neat cement and water or cement, sand, and water to a consistency similar to that of thick cream.

1. For latex-modified, portland cement, setting-bed mortar, substitute latex admixture for part or all of water, according to latex-additive manufacturer's written instructions.

E. Pigmented Mortar: Use colored cement product.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Preblended dry mix to match Architect's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.

B. Examine substrate to verify that dovetail slots, other items installed in substrates and required for or extending into stone masonry are correctly installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 SETTING OF STONE MASONRY, GENERAL

A. Anchor stone masonry to concrete with corrugated-metal veneer anchors unless otherwise indicated. Secure anchors by inserting dovetailed ends into dovetail slots in concrete.

B. Perform necessary field cutting and trimming as stone is set.

1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
2. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
3. Pitch face at field-split edges as needed to match stones that are not field split.

C. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.

D. Arrange stones in broken-range ashlar pattern with uniform course heights, random lengths, and uniform joint widths.

E. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.

F. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

G. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 3/8 inch (10 mm) at narrowest points or more than 5/8 inch(16 mm) at widest points.

H. Provide sealant joints of widths and at locations indicated.

1. Keep sealant joints free of mortar and other rigid materials.
2. Sealing joints is specified in Section 079200 "Joint Sealants."

I. Install embedded cap flashing at top of masonry, to promote downward or outward flow of water in wall, and where indicated.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (13 mm in 12 m) or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.

B. Variation from Level: For bed joints and lines of exposed sills, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.

C. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.

D. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.

3.5 INSTALLATION OF ADHERED STONE MASONRY VENEER

A. Coat backs of stone units and face of masonry backup with cement-paste bond coat, then butter both surfaces with setting mortar. Use sufficient setting mortar so a slight

excess will be forced out the edges of stone units as they are set. Tap units into place, completely filling space between units and masonry backup.

B. Rake out joints for pointing with mortar to depth of not less than 3/4 inch (19 mm) before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.6 POINTING

A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch (10 mm) deep until a uniform depth is formed.

B. Point stone joints by placing and compacting pointing mortar in layers of not more than 3/8 inch (10 mm) deep. Compact each layer thoroughly and allow to it become thumbprint hard before applying next layer.

C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:

1. Joint Profile: Concave.

3.7 ADJUSTING AND CLEANING

A. Remove and replace stone masonry of the following description:

1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
2. Defective joints.
3. Stone masonry not matching approved samples and mockups.
4. Stone masonry not complying with other requirements indicated.

B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
5. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20, Revised II, using job-mixed detergent solution.
6. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.

3.8 EXCESS MATERIALS AND WASTE

A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION 04 4313.16

SECTION 05 7000 - DECORATIVE METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative stainless steel seat wall caps, and integral stainless steel structural supports.
2. Decorative stainless steel wall cap at retaining wall.
3. Decorative stainless steel faced campus name panels, and aluminum frame.
4. Decorative stainless steel changeable banner frame.

B. Related Sections:

1. Section 10 1419 "Dimensional Letter Signage" for non-decorative metal fabrications.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design decorative metal fabrications, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated on Drawing S-001 – Structural General Notes.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including finishing materials.

B. Shop Drawings: Show fabrication and installation details for decorative metal.

1. Include plans, elevations, component details, and attachments to other work.
2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

C. Samples for Initial Selection: For products involving selection of color, texture, or design including mechanical finishes.

D. Samples for Verification: For each type of exposed finish required.

1. Sections of linear shapes.
2. Samples of welded and brazed joints showing quality of workmanship.

E. Delegated Design Submittal: For installed fabrications indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer and fabricator.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Installer Qualifications: Fabricator of products.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.6, "Structural Welding Code - Stainless Steel."

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for the following types of decorative metal:

a. Incorporate decorative stainless steel seat wall cap as part of the mockup required by Section 04 4313.16 – “Adhered Stone Masonry Veneer”.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.2 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

B. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.

C. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M) or ASTM B 483/B 483M, Alloy 6063-T832.

D. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003-H14 or Alloy 5005-H32.

2.3 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 304.

B. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304.

C. Bars and Shapes: ASTM A 276, Type 304.

2.4 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:

1. Aluminum Items: Type 316 stainless-steel fasteners.
2. Stainless-Steel Items: Type 316 stainless-steel fasteners.
3. Dissimilar Metals: Type 316 stainless-steel fasteners.

B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless exposed fasteners are unavoidable.

1. Provide square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

E. Post-Installed Anchors: Torque-controlled expansion type.

1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2(A4) stainless-steel bolts, ASTM F 593(ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

C. Graffiti-Resistant Coating: Clear, two-component waterborne urethane-silicone polymer coating. Coating shall be formulated for spray, roller or brush application, and as follows:

1. Application: Exposed surfaces.
2. Low VOC formula.
3. Coats: One.
4. Finish: Satin.
5. UV resistant.
6. Basis-of-Design Product: No. EC-1830 coating manufactured by Ecological Coatings, LLC, Clifton Park NY, www.EcologicalCoatings.com; or comparable product subject to compliance with requirements.

2.6 FABRICATION, GENERAL

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional

adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

C. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

F. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

G. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

I. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

J. Comply with AWS for recommended practices in shop welding and brazing. Weld and braze behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.

1. Where welding and brazing cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: No evidence of a welded joint.

K. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.9 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Directional Satin Finish: No. 4.

C. Dull Satin Finish: No. 6.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

H. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.

I. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

J. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

K. Graffiti Protection: Apply graffiti-resistant coating to exposed surfaces of aluminum and stainless steel. Comply with manufacturer’s instructions for surface preparation, and application. To the greatest extent possible shop apply graffiti-resistant coating.

1. Shop-Finish Touchup: Clean abraded areas and repair with same graffiti protection coating used for shop finish, according to manufacturer's written instructions.

L. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.

M. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 7000

SECTION 06 1053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

A. Section Includes:

1. Wood blocking.

1.2 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NHLA: National Hardwood Lumber Association.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Expansion anchors.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC3b for exterior construction not in contact with the ground].

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX).

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.3 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

C. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide blocking as indicated and as required to support facing materials, fixtures, specialty items, and trim.

B. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

C. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use copper naphthenate for items not continuously protected from liquid water.

D. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

3.2 PROTECTION

A. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 1053

SECTION 07 9200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Preformed joint sealants.

B. Related Sections:

1. Section 04 4313.13 "Adhered Stone Masonry" for sealing joints in adhered stone masonry and sealing joints between stone masonry and stainless steel decorative metals.
2. Section 05 5000 “Decorative Metal” for sealing joints in stainless steel cap plates.
3. Section 32 1400 "Unit Paving" for sealing joints in pavements, walkways, and curbing.

1.2 PRECONSTRUCTION TESTING

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

D. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

D. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Building Products: Omniseal 50.
b. Dow Corning Corporation; 756 SMS, or 791.
c. GE Advanced Materials - Silicones; SilPruf SCS2000 or UltraPruf II SCS2900.
d. May National Associates, Inc.; Bondaflex Sil 295.
e. Polymeric Systems, Inc.; PSI-641.
f. Sika Corporation, Construction Products Division; SikaSil-C995.
g. Tremco Incorporated; Spectrum 2 or Spectrum 3.

2.3 PREFORMED JOINT SEALANTS

A. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. (160 kg/cu. m) and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dayton Superior Specialty Chemicals; Polytite Standard.
   b. EMSEAL Joint Systems, Ltd.; Emseal 25V.
   c. Sandell Manufacturing Co., Inc.; Polyseal.
   d. Schul International, Inc.; Sealtite 50N.
   e. Willseal USA, LLC; Willseal 600.

2.4 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Masonry.

3. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

G. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes

so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

a. Control joints in adhered stone masonry.
b. Joints between cast-in-place concrete and adhered stone masonry.
c. Control joints in stainless steel seat wall cap.
d. Joints between different materials listed above.
e. Joints between stainless steel wall cap and items built into stone walls.
f. Other joints as indicated.

2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 50.
3. Preformed Joint Sealant: Preformed compressible foam, where indicated.
4. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 9200

SECTION 10 1419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast dimensional characters.

B. Related Sections:

1. Section 05 7000 – “Decorative Metal” for stainless steel fabrications supporting dimensional letter signage.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For dimensional letter signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
3. Show locations of electrical service connections.
4. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Dimensional Characters: Full-size Sample of one dimensional character.
2. Exposed Accessories: Full-size Sample of each accessory type.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer of products.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 DIMENSIONAL CHARACTERS

A. Formed or Fabricated Channel Characters: Metal face and side returns with rear closure face and internal reinforcing plate, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally reinforced and braced for stability and for securing fasteners; and as follows.

1. Weeps: Provide weep holes to drain water at lowest part of exterior characters. Equip weeps with permanent baffles to block light leakage without inhibiting drainage.

2. Character Material: Sheet or plate stainless steel.

a. Material Thickness: 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.79 mm) thick for returns.

3. Internal Reinforcing Material: Plate aluminum.

a. Material Thickness: 0.25 inch (6.35 mm)

4. Character Height: As indicated.
5. Character Depth: As indicated.
6. Finishes:

a. Integral Aluminum Finish: Mill finish.
b. Integral Stainless-Steel Finish: No. 6 – dull satin.

7. Concealed Mounting: As indicated on detail 3/A203.
8. Typeface: Meta Condensed Bold.

2.3 DIMENSIONAL CHARACTER MATERIALS

A. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, stretcher-leveled standard of flatness.

D. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.

B. Sign Mounting Fasteners:

1. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 2 (A4).

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Graffiti-Resistant Coating: Clear, two-component waterborne urethane-silicone polymer coating. Coating shall be formulated for spray, roller or brush application, and as follows:

1. Application: Exposed surfaces.
2. Low VOC formula.
3. Coats: One.
4. Finish: Satin.
5. UV resistant.
6. Basis-of-Design Product: No. EC-1830 coating manufactured by Ecological Coatings, LLC, Clifton Park NY, www.EcologicalCoatings.com; or comparable product subject to compliance with requirements.

2.5 FABRICATION

A. General: Provide manufacturer's dimensional letter sign assemblies according to requirements indicated.

B. Preassemble each dimensional letter in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling, and installation limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.

C. Mill joints to a tight, hairline fit. Cope or miter corner joints.

D. Form assemblies and joints exposed to weather to resist water penetration and retention.

E. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.

1. Where welding and brazing cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint.

F. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.

G. Internally brace signs with aluminum plate for stability and for securing fasteners.

H. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Dull Satin Finish: No. 6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to fabricator's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Place sign in position and flush to surface. Install through fasteners and tighten.

C. Graffiti Protection: Apply graffiti-resistant coating to exposed surfaces of aluminum and stainless steel. Comply with manufacturer’s instructions for surface preparation, and application. To the greatest extent possible shop apply graffiti-resistant coating.

1. Shop-Finish Touchup: Clean abraded areas and repair with same graffiti protection coating used for shop finish, according to manufacturer's written instructions.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes

or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 1419

SECTION 10 1463 – LED DISPLAY SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. LED display panel and program control unit designed for singled-sided display/viewing.
2. Program signal devices.
3. System wire and cable.

1.2 DEFINITIONS

A. NIST: The National Institute of Science and Technology.

B. PC: Personal computer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:

1. LED display panel.
2. Signal equipment.
3. Equipment enclosures.
4. Accessory components.

B. Shop Drawings: For LED display panel. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring circuits.

a. Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
b. Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Show protection from overcurrent, static discharge, and voltage surge.

C. Samples for Initial Selection:

1. Manufacturer's color photographs or color chips showing the full range of colors available for display panel enclosure.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace LED panel display system that fails in operating systems, materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; need for excessive maintenance; and similar unusual, unexpected, and unsatisfactory conditions.
2. System Warranty Period: Five years from date of Substantial Completion.
3. Parts Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LED DISPLAY SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide “W-series” manufactured by Watchfire Signs.

B. LED Display System Functions and Features:

1. Video and Graphics Capability: Display shall show pre-recorded video clips at 30 frames per second, minimum. Software driving display shall have capacity to import AVI, BMP, GIF, JPG and other graphic file types.
2. Temperature Sensor: Provide sensor for real time display of temperature; or temperature shall be displayed on LED panel using real time data from a RSS internet feed.
3. Data Integration: Display shall have capacity to display RSS feeds for real time data, including news, sports, weather, Amber Alerts, etc.

4. Communication: LED display shall use long-range high-speed secure radio communication with minimum range of 1000 feet. If actual range is less than 1000 feet, fog and other environmental interference shall not affect signal.

    a. Radio communication shall connect the display controller to the Owner's network.
    b. Updates and control of the display panel shall utilize the manufacturer's software over the Owner's network.
    c. Provide capacity for hard-wired connection to Owner's network. Refer to Electrical Drawings for location of buried conduit to house cabling. If Owner determines that hard-wired connection is required, cable and final connections to network will be installed by the Owner.

5. Computer: Manufacturer's display control software shall be loaded and set-up on Owner-furnished computer by Installer or manufacturer's representative.
6. Software: Display software furnished shall include two software licenses and two USB software keys per site.

    a. Software shall be capable of operating on Windows platform, and have capability of editing, scheduling, verifying performance, 3rd part software importation, font editor, and true type font use from the Owner's font library.
    b. Include overview of features of the display software and hardware requirements with the Contractor's bid proposal.

7. Security: Password protection shall be built into the display software, as well as extra security measure of a USB software key that will enable updating of the display. Software shall not have the capability to update the display without the required USB software key and password.

C. Display Panel Features:

1. Pixel Spacing: Center to center pixel spacing shall not exceed 16.5 mm (0.65 inch).
2. Pixel Design: Each pixel shall be separate from one another. Virtual or hybrid pixel technologies shall be acceptable. Each pixel shall be comprised of one red, one green, and one blue LED.
3. Half-Brightness Viewing Angles: 140 degrees horizontal; 70 degrees vertical.
4. Brightness and Dimming: Maximum brightness shall be 10,000 nits, minimum. Dimming shall be automated using software dimming based on global position of the LED display.
5. LED's shall have a lifetime expectancy of 100,000 hours.

    a. Lifetime is defined as the point at which the LED degradation reaches 50% of original brightness.
    b. Rating shall also be based on continuous operation at 100% nit level output as indicated in the above brightness criteria.

6. Color Capability: Display shall be capable of displaying no less than 144 quadrillion colors.

7. Matrix: LED display shall be 96 pixels high by 168 pixels wide.
8. Character Capability: LED display shall show no less than 12 lines of text with 34 characters horizontally.

    a. Minimum character size shall be no greater than 4½ inches.
    b. Display shall have ability to display true type fonts and fixed-width fonts.

9. LED and Pixel Density: LED display shall have 3670 pixels minimum per square meter and 11,010 LED's per square meter.

    a. Total LED count for the display shall be 16, 128 minimum; 5376 red LED's, 5376 green LED's, and 5376 blue LED's.

10. LED display shall include internal surge suppression.

D. Display Panel Cabinet:

1. Size: Each face shall be 67½ high by 112¼ long by 8 inches deep.
2. Materials: Cabinet shall be constructed of extruded aluminum, featuring precision mitered corners, solid welds, and 30% gloss black polyurethane finish.
3. Windowless Design: LED modules shall be mounted to the front of the cabinet without being covered by lexan or other transparent face.
4. Display Access: LED display shall have front access for maintenance and repair.
5. LED modules shall be encapsulated for protection from the environment and shall be fully submersible under water to demonstrate weatherproof capability.

E. Operating Software: Include content DVD with manufacturer's control software and be pre-loaded with a minimum of 1200 pre-produced content files formatted to the display size as specified.

1. Content shall include animations and backgrounds that can be utilized on the display without size modification.
2. Pre-produced content files shall not be specific to any industry type.

2.2 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG. Voltage drop for signal, and control circuits shall not exceed 10 percent under peak load conditions.

B. 120-V AC and Class 1 Signal and Control Circuits: Stranded, single conductors of size and type recommended by system manufacturer.

C. Class 2 and Class 3 Signal and Control Circuits: Single conductor or twisted-pair cable, unshielded, unless manufacturer recommends shielded cable.

D. Data Circuits: Category 6 minimum, unshielded, twisted-pair cable, unless manufacturer recommends shielded cable.

E. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.

F. Conductor Color-Coding: Uniformly identified and coordinated with wiring diagrams.

G. Shielding: For speaker-microphone leads and at other locations recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.

1. Minimum Shielding Coverage on Conductors: 60 percent.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 ELECTRICAL CONNECTIONS

A. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

B. Use plug connectors for connections.

C. Ground display panel, programming equipment, and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.3 IDENTIFICATION

A. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of LED display panel, and all programming and manually programmed signal and relay operating functions.
2. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

D. LED display signage system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 ADJUSTING

A. Program system according to Owner's requirements. Program equipment-control output circuits to suit Owner's operating schedule for equipment controlled.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain LED display signage program-control system components.

1. Provide one additional follow-up one-on-one webinar or telephone training session.

END OF SECTION 10 1463

SECTION 26 5600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.

1.2 ACTION SUBMITTALS

A. Product Data: For each luminaire, arranged in order of lighting unit designation. Include data on features, accessories, and finishes; and comply with requirements on the Electrical Drawings.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.4 WARRANTY

A. Special Warranty: Refer to Drawing E001 for warranty requirements.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Products: Subject to compliance with requirements, provide products scheduled on the Drawings, and as described by the attachments at the end of this Section.

PART 3 - EXECUTION

3.1 FIXTURE INSTALLATION

A. Refer to the attached installation instructions Fixture Types A & C from iGuzzini, 9 pages, and as indicated on the Drawings.

B. Refer to the attached installation instructions for Fixture Type B from iGuzzini, 6 pages, and as indicated on the Drawings.

END OF SECTION 26 5600

FIXTURE TYPE A

iGuzzini NORTH AMERICA

SPECIFICATION SHEET

LIGHT UP WALK PROFESSIONEL

#I.B016 - 277 -13
VOLTAGE FINISH

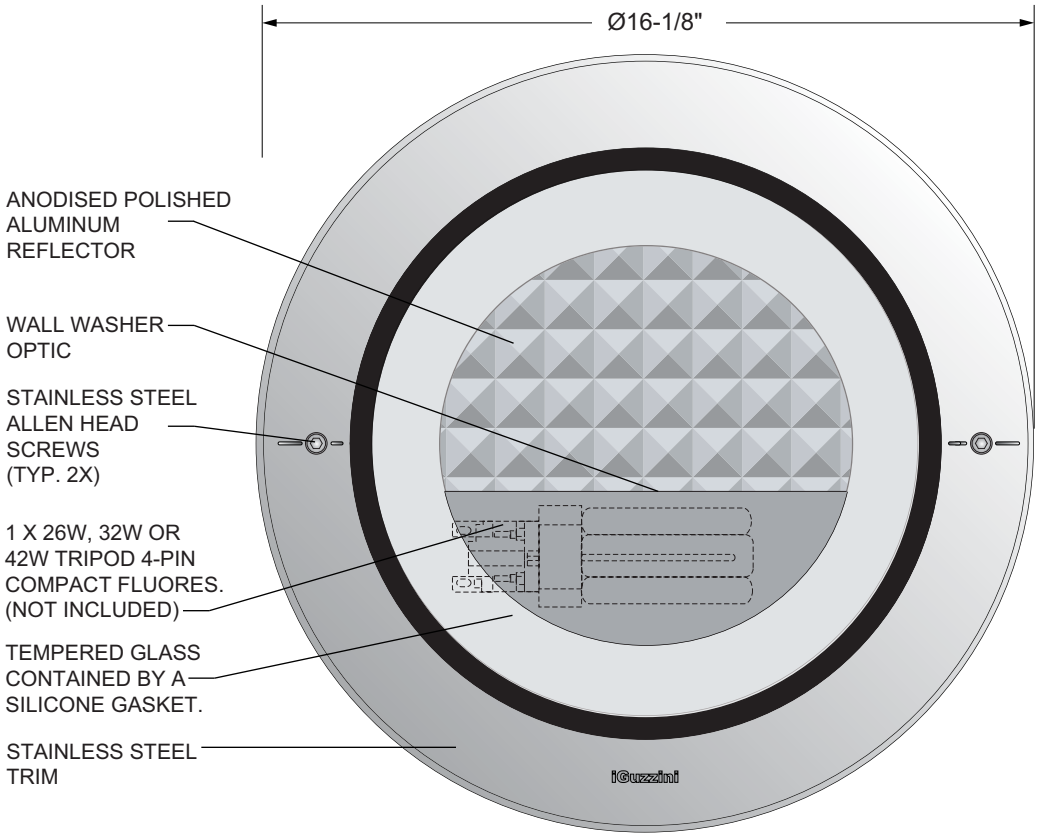
In-ground recessed luminaire with a wall washer optic. Cast aluminum body and outer casing. Trim and vandal resistant screws are made of stainless steel.The total assembly can whithstand a load of 5000 Kg (11 000 lbs) at a maximum speed of 50 Km/h (31 mph).

LAMPING: 1 X 26W, 32W OR 42W TRIPOD COMPACT FLUORESCENT 4-PIN, GX24q-3/4 BASE

PROJECT NAME: _____

TYPE: _____

LAST UPDATE: FEBRUARY 24th, 2009



TOP VIEW

ACCESSORIES
TO BE ORDERED SEPERATELY

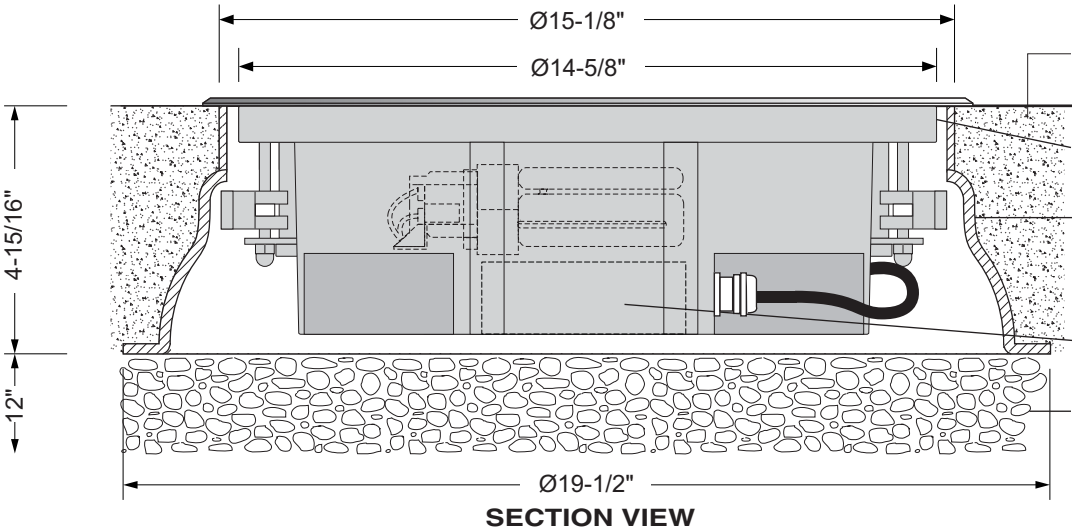
- ○ B903 - CASING
  - 04 - BLACK

- ○ B919 - COLORED FILTERS
  - 00 - FROSTED
  - 05 - RED
  - 06 - YELLOW
  - 09 - BLUE

- ○ B916 - SUCTION CUP

VOLTAGE
○ 120V ✓ 277V

METAL FINISH
✓ 13 - STAINLESS STEEL



SECTION VIEW

c UL us

5455 de Gaspé
suite 100, Montréal (Québec)
Canada H2T 3B3
P.: 514.523.1339 F.: 514.525.6107

LIGHT UP WALK
PROFESSIONEL

FIXTURE TYPE B

iGuzzini NORTH AMERICA

SPECIFICATION SHEET

LINEALUCE RECESSED #I.78___ - 277 - 15
LAMPING VOLTAGE FINISH

LIGHT UP WALK PROFESSIONAL

Recessed luminaire with assymetrical optic. Suitable for multiple locations: walls, ceilings or floors. Casing and vandal resistant screws are made of stainless steel. The tempered glass resist a dynamic load of 11 lbs. The total assembly can withdstand a static load of 2 200 lbs.

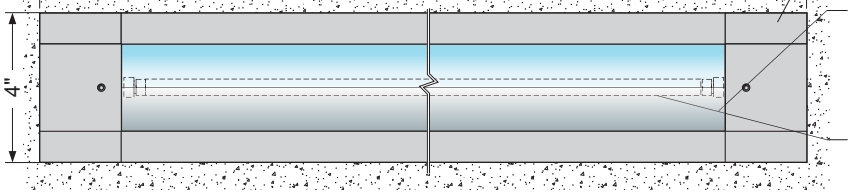
LAMPING: 1 X (14,21,28 OR 35)W T5 FLUORESCENT

PROJECT NAME: _____

TYPE: B

LAST UPDATE: FEBRUARY 24th, 2009

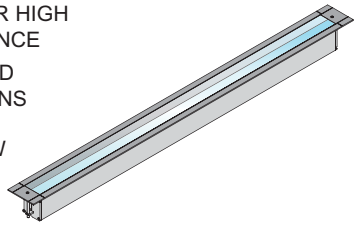
TOP VIEW
VARIABLE LENGTHS
(SEE **MODELS**)



DIE-CAST ALUMINUM TOP COVER POWDER COATED FOR HIGH CORROSION RESISTANCE

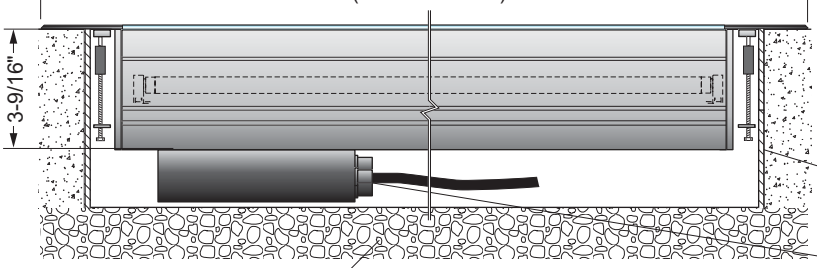
TEMPERATURE & LOAD RESISTANT GLASS LENS

1 X (14, 21, 28 OR 35)W T5 FLUORESCENT (NOT INCLUDED)



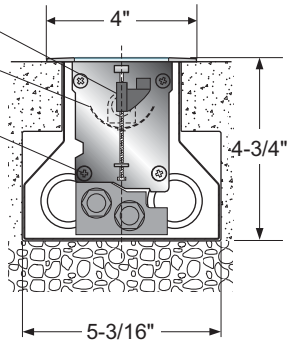
STAINLESS STEEL ALLEN HEAD SCREW WITH INTERNAL ADJUSTABLE LOCKING SYSTEM (TYP.2X)

FRONT VIEW
VARIABLE LENGTHS
(SEE **MODELS**)



GRAVEL FOR DRAINAGE

SECTION VIEW



ALUMINUM REFLECTOR

ANCHOR POINTS FOR INSTALLATION SYSTEMS

STAINLESS STEEL CASING **(TO BE ORDERED SEPERATELY)**

CONNECTION BOX WITH DOUBLE CABLE ENTRY & POWER CORD

MODEL

code	length	lamp
◯ **I.7879**	26-1/4" (668mm)	1 X 14W LAMP
◯ **I.7880**	38-1/4" (972mm)	1 X 21W LAMP
◯ **I.7881**	50" (1268mm)	1 X 28W LAMP
◯ **I.7882**	61-3/4" (1568mm)	1 X 35W LAMP

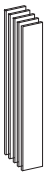
CASING

code	length	lamp
◯ **I.5902**	25-1/2" (648mm)	1 X 14W LAMP
◯ **I.5903**	37-1/2" (953mm)	1 X 21W LAMP
◯ **I.5904**	49-1/4" (1250mm)	1 X 28W LAMP
◯ **I.5905**	61" (1550mm)	1 X 35W LAMP

VOLTAGE ◯ 120V ☑ 277V

METAL FINISH ☑ 15 - DARK GREY

ACCESSORIES & INSTALLATION SYSTEMS
TO BE ORDERED SEPERATELY



COLOURED FILTERS	length
◯ **I.5504**for I.7879	22-1/2"
◯ **I.5505** for I.7880	34-3/8"
◯ **I.5506** for I.7881	46-1/8"
◯ **I.5507** for I.7882	58"

05 - RED 07 - GREEN 65 - NITRIC
06 - YELLOW 09 - SKY BLUE

MICRO PERFORATED SCREENS	length
◯ **I.5914** for I.7879	22-1/2"
◯ **I.5915** for I.7880	34-3/8"
◯ **I.5916** for I.7881	46-1/4"
◯ **I.5917** for I.7882	58"

04 - BLACK

SUSPENSION CABLES	length
◯ **I.5926** ceiling	22-3/8"
◯ **I.5925** wall	7-7/8"

c UL us

5455 de Gaspé
suite 100, Montréal (Québec)
Canada H2T 3B3
P.: 514.523.1339 F.: 514.525.6107

FIXTURE TYPE C

iGuzzini NORTH AMERICA

SPECIFICATION SHEET

LIGHT UP WALK
PROFESSIONAL

#I.B010 - 277
VOLTAGE

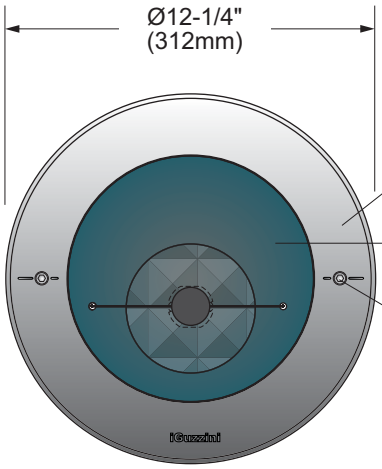
In-ground recessed luminaire with an adjustable optic. Cast aluminum body and outer casing. Trim and vandal resistant screws are made of stainless steel. The double layer of tempered glass reduces the surface temperature.

LAMPING: 1 X 26W, 32W OR 42W TRIPOD COMPACT FLUORESCENT 4-PIN, GX24q-3/4 BASE

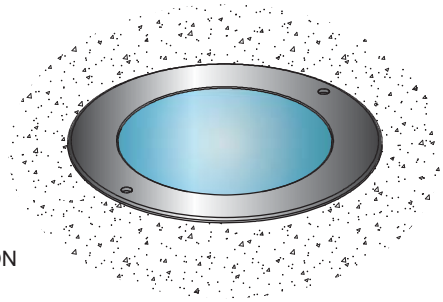
PROJECT NAME: _____

TYPE: C

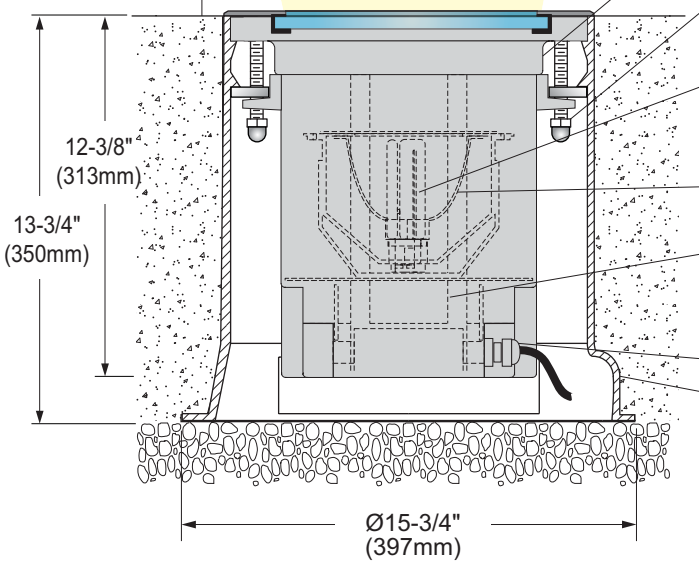
LAST UPDATE: FEBRUARY 24th, 2009



TOP VIEW



ISOMETRIC VIEW



SECTION VIEW

INSURE 12" OF GRAVEL FOR DRAINAGE

ACCESSORIES
TO BE ORDERED SEPERATELY

◯ B902 - CASING
04 - BLACK

◯ B918 - COLORED FILTERS
00 - FROSTED
05 - RED
06 - YELLOW
09 - BLUE

◯ B922 - REFRACTOR
FOR ELEPTICAL DISTRIBUTION

◯ B916 - SUCTION CUP

VOLTAGE
◯ 120V ☑ 277V

LAMPING
◯ 1 X 26W TRIPOD, 4-PIN, COMPACT FLUORESCENT, Gx24q-3 BASE
◯ 1 X 32W TRIPOD, 4-PIN, COMPACT FLUORESCENT, Gx24q-3 BASE
◯ 1 X 42W TRIPOD, 4-PIN, COMPACT FLUORESCENT, Gx24q-4 BASE

c UL us
5455 de Gaspé
suite 100, Montréal (Québec)
Canada H2T 3B3
P.: 514.523.1339 F.: 514.525.6107

LIGHT UP WALK PROFESSIONAL

1.154.335.05 IS00132/05

INSTALLATION INSTRUCTIONS FIXTURE TYPES A & C

ISTRUZIONI PER L'INSTALLAZIONE DEL SISTEMA "LIGHT - UP WALK PROFESSIONAL"
INSTALLATION INSTRUCTIONS FOR "LIGHT - UP WALK PROFESSIONAL" SYSTEM
MODE D'INSTALLATION DU SYSTEME "LIGHT - UP WALK PROFESSIONAL"
HINWEISE ZUR INSTALLATION DER "LIGHT - UP WALK PROFESSIONAL"
INSTRUCTIES VOOR HET INSTALLEREN VAN HET "LIGHT - UP WALK PROFESSIONAL"
INSTRUCCIONES PARA LA INSTALACIÓN DEL SISTEMA "LIGHT - UP WALK PROFESSIONAL"
INSTALLATIONSVEJLEDNING TIL SYSTEMET "LIGHT - UP WALK PROFESSIONAL"
INSTALLASJONSANVISNING FOR SYSTEMET "LIGHT - UP WALK PROFESSIONAL"
INSTALLATIONSANVISNINGAR FÖR SYSTEM "LIGHT - UP WALK PROFESSIONAL"
ИНСТРУКЦИИ ПО МОНТАЖУ СИСТЕМЫ« LIGHT - UP WALK PROFESSIONAL »
" LIGHT - UP WALK PROFESSIONAL "系统的安装说明

ATTENZIONE:
LA SICUREZZA DELL'APPARECCHIO E' GARANTITA SOLO CON L'USO APPROPRIATO DELLE SEGUENTI ISTRUZIONI; PERTANTO E' NECESSARIO CONSERVARLE.

WARNING:
THE SAFETY OF THIS FIXTURE IS GUARANTEED ONLY IF YOU COMPLY WITH THESE INSTRUCTIONS; REMEMBER TO CONSERVE IN A SAFE PLACE.

ATTENTION:
LA SECUTIE DE L'APPAREIL N'EST GARANTIE QU'EN CAS D'UTILISATION CORRECTE DES INSTRUCTIONS SUIVANTES; IL FAUT PAR CONSEQUENT LES CONSERVER.

ACHTUNG:
DIE SICHERHEIT DES GERÄTES WIRD NUR DURCH SACHGEMÄSSE BEFOLGUNG NACHSTEHENDER ANWEISUNGEN GEWÄHRLEISTET; IHRE AUFBEWAHRUNG IST DESHALB SEHR WICHTIG.

OPGELET:
DE VEILIGHEID VAN DI ATOESTEL IS SLECHTS DAN GEGARANDEERD ALS INDIEN DE VOLGENDE INSTRUCTIES STRIKT WORDEN TOEGEPAST: DAAROM MOET MEN ZE OOK BEWAREN.

ATENCION:
LA SEGURIDAD DEL APARATO SE GARANTIZA SOLO CUMPLIENDO CUIDADOSAMENTE LAS SIGUIENTES INSTRUCCIONES; POR ELLO, ES NECESARIO CONSERVARLAS.

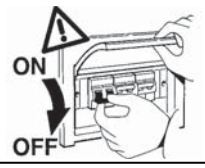
BEMÆRK:
SIKKERHEDEN VED BRUG AF ARMATURET KAN KUN GARANTERES, HVIS DISSE ANVISNINGER FØLGES; SØRG DERFOR FOR AT GEMME DEM.

ADVARSEL:
SIKKERHETEN TIL DETTE APPARATET GARANTERES KUN HVIS DU OVERHOLDER DISSE INSTRUKSJONENE; HUSK Å OPPBEVARE DEM PÅ ET TRYGT STED.

OBSERVERA!
UTRUSTNINGENS SÄKERHET KAN ENDAST GARANTERAS OM DESSA ANVISNINGAR RESPEKTERAS I DETALJ. SPARA DÄRFÖR DESSA ANVISNINGAR FÖR FRAMTIDA KONSULTATION.

ВНИМАНИЕ:
МЫ ГАРАНТИРУЕМ БЕЗОПАСНУЮ ЭКСПЛУАТАЦИЮ ИЗДЕЛИЯ ТОЛЬКО ПРИ СОБЛЮДЕНИИ СЛЕДУЮЩИХ ИНСТРУКЦИЙ; С ЭТОЙ ЦЕЛЬЮ НЕОБХОДИМО СОХРАНИТЬ ДАННУЮ БРОШЮРУ.

警告：
为确保该装置安全，请遵守操作指示；并于安全场所放置。



N.B.: DURANTE L'INSTALLAZIONE DEL SISTEMA "LIGHT - UP WALK PROFESSIONAL" RISPETTARE SCRUPOLOSAMENTE LE NORME IMPIANTISTICHE NAZIONALI VIGENTI.

N.B.: WHEN INSTALLING THE "LIGHT - UP WALK PROFESSIONAL" SYSTEM, MAKE SURE ALL CURRENT NATIONAL REGULATIONS RELATING TO INSTALLATION ARE OBSERVED.

N.B.: LORS DE L'INSTALLATION DU SYSTÈME "LIGHT - UP WALK PROFESSIONAL" VEUILLEZ RESPECTER RIGOUREUSEMENT LES NORMES EN VIGUEUR EN LA MATIÈRE DANS LE PAYS.

N.B.: BEACHTEN SIE BEI DER INSTALLATION DES SYSTEMS "LIGHT - UP WALK PROFESSIONAL" UNBEDINGT DIE IM LAND GELTENDEN ANLAGETECHNISCHEN VORSCHRIFTEN.

N.B.: BIJ HET INSTALLEREN VAN HET "LIGHT - UP WALK PROFESSIONAL" SYSTEEM MOET U DE GELDENDE NATIONALE INSTALLATIENORMEN STRIKT NALEVEN.

NOTA: DURANTE LA INSTALACIÓN DEL SISTEMA "LIGHT - UP WALK PROFESSIONAL" RESPETAR ESCRUPULOSAMENTE LAS NORMAS NACIONALES DE INSTALACIÓN EN VIGOR.

N.B.: UNDER INSTALLATION AF "LIGHT - UP WALK PROFESSIONAL" SYSTEMET SKAL MAN NØJE OVERHOLDE DE GÆLDENDE REGLER FOR DISSE ANLÆG.

N.B.: UNDER INSTALLASJON AV SYSTEMET "LIGHT - UP WALK PROFESSIONAL" MÅ DE NASJONALE ANLEGGSFORSKRIFTENE OVERHOLDES NØYE.

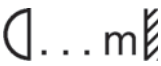
OBS! UNDER INSTALLATIONEN AV SYSTEMET "PUBLIC" SKA GÄLLANDE NATIONELLA INSTALLATIONSFÖRESKRIFTER RESPEKTERAS I DETALJ.

ПРИМЕЧАНИЕ: В ПРОЦЕССЕ МОНТАЖА СИСТЕМЫ" LIGHT - UP WALK PROFESSIONAL " СТРОГО СОБЛЮДАЙТЕ НАЦИОНАЛЬНЫЕ ДЕЙСТВУЮЩИЕ НОРМАТИВЫ ПО ЭЛЕКТРОПРОВОДКЕ.

注意：在安装"LIGHT - UP WALK PROFESSIONAL"系统时请谨守设备的安装规定。

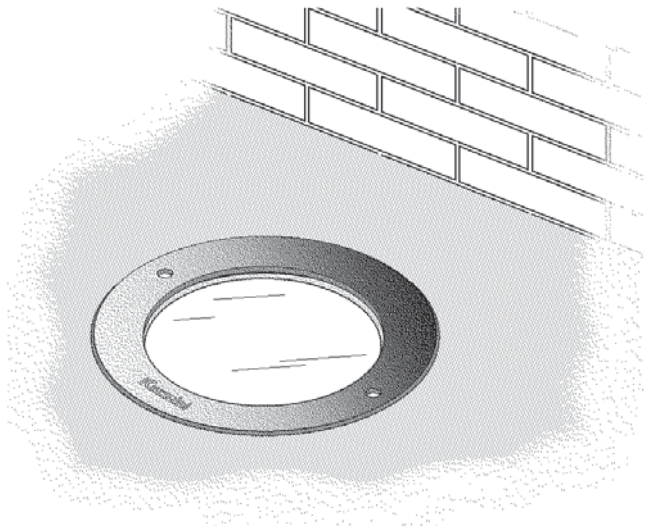
art. B021 - B023 - B238 - B250

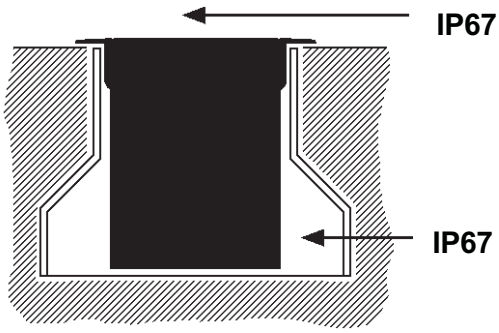
N.B.: L'INSTALLAZIONE DEI PRODOTTI E' CONSENTITA SOLAMENTE IN AREE A CIRCOLAZIONE LIMITATA.
N.B.: INSTALLATION OF THE PRODUCTS IS ALLOWED IN AUTHORISED TRAFFIC AREAS ONLY.
N.B.: L'INSTALLATION DE CES PRODUITS N'EST PERMISE QUE DANS DES ZONES A CIRCULATION LIMITEE.
N.B.: DIE INSTALLATION DER PRODUKTE IST NUR INZONEN BEGRENZTEN VERKEHRS GESTATTET.
N.B.: HET INSTALLEREN VAN DE PRODUCTEN IS SLECHTS TOEGESTAAN IN ZONES WAAR HET VERKEER BEPERKT IS TOT GEAUTORISEERDE PERSONEN.
NOTA: LA INSTALACIÓN DE LOS PRODUCTOS ESTÁ PERMITIDA SOLAMENTE EN ÁREAS DE CIRCULACIÓN RESTRINGIDA.
N.B.: INSTALLATION AF PRODUKTERNE ER KUN TILLADT I OMRÅDER MED BEGRÆNSET TRAFIK.
N.B.: INSTALLERING AV PRODUKTENE ER KUN TILLAT PÅ STEDER MED BEGRENSET TRAFIKK.
OBS! PRODUKTERNA FÅR ENDAST INSTALLERAS I OMRÅDEN MED BEGRÄNSAD CIRKULATION.
ПРИМЕЧАНИЕ:МОНТАЖ ИЗДЕЛИЙ ДОПУСКАЕТСЯ ТОЛЬКО В ЗОНАХ С ОГРАНИЧЕННЫМ АВТОМОБИЛЬНЫМ ДВИЖЕНИЕМ.
注意，产品仅在授权的交通频繁区域才允许安装。



art. B023
B250

I Rispettare la distanza minima dall'oggetto illuminato, misurata lungo l'asse ottico della lampada.
GB Respect the minimum distance from the illuminated object, measured along the optical axis of the lamp.
F Respectez la distance minimum de l'objet éclairé, mesurée le long de l'axe optique de la lampe.
D Halten Sie bitte den längs zur optischen Achse der Leuchte gemessenen Mindestabstand zum beleuchteten Gegenstand ein.
NL Respecteer de minimum afstand van het verlichte object, gemeten langs de optische as van de lamp.
E Respetar la distancia mínima respecto del objeto iluminado, medida a lo largo del eje óptico de la lámpara.
DK Minimumsafstanden til det oplyste objekt skal overholdes, målt langs pærens optiske akse.
N Overhold minimal avstand fra gjenstanden som skal belyses, målt langs lampens optiske akse.
S Respektera minimiavståndet från det belysta föremålet. Avståndet har uppmätts längs lampans optiska axel.
RUS Соблюдайте минимальное расстояние от освещенного объекта, измеренного вдоль оптической оси лампы.
CN 保持沿灯泡光学轴线测量与被照产品的最小距离。





I Installando il prodotto a plafone in un vano chiuso , il grado di protezione è quello indicato in figura.

GB If you install the product on the ceiling in a closed room, the degree of protection is that indicated in the figure.

F En cas d'installation du produit au plafond dans une niche fermée, l'indice de protection est celui qui est indiqué sur la figure.

D Wenn Sie das Deckenmodell in einem geschlossenen Raum installieren, so entspricht der Schutzgrad den Werten in der Abbildung.

NL Bij installatie aan het plafond in een gesloten ruimte is de protectiegraad zoals aangegeven in de afbeelding.

E Instalando el producto como plafón en un compartimiento cerrado, el grado de protección es el que se indica en la figura.

DK Hvis produktet monteres i loftet i et lukket rum, er beskyttelsesgraden som vist i figuren.

N Hvis du installerer produktet på taket i et lukket rom, er beskyttelsesgraden den som er indikert på figuren.

S Genom att installera innertaksbelysningen i ett stängt rum, är skyddsgraden densamma som anges i figuren.

RUS При монтаже плафонного прибора в закрытом отсеке класс электробезопасности будет таким, как указано на схеме.

CN 如要将产品安装在密闭房间的天花板上，保护等级如表中所示。

I **N.B.:** Si consiglia di effettuare le operazioni d'installazione o di manutenzione all'interno del vano ottico, in ambienti interni o quanto meno in assenza di umidità o pioggia.

GB **N.B.:** Installation and maintenance operations must be carried out inside the optical assembly, indoor and in a place with no humidity or rain.

F **N.B.:** Pour effectuer les opérations d'installation ou d'entretien des composants intérieurs du bloc optique, il est conseillé de se rendre dans un espace clos, ou tout du moins à l'abri de l'humidité ou de la pluie.

D **Hinweis:** Es empfiehlt sich, alle Installations- oder Wartungseingriffe am Leuchtengehäuse in geschlossenen Räumen bzw. bei trockenen Luftverhältnissen vorzunehmen (Feuchtigkeit und Regen vermeiden).

NL **N.B.:** We raden u aan de installatie- of onderhoudshandelingen van de optische behuizing binnenshuis uit te voeren, of in ieder geval in een omgeving waar geen vocht of regen is.

E **N.B.:** Se recomienda efectuar las operaciones de instalación o mantenimiento dentro del cuerpo óptico, en interiores o por lo menos en ausencia de humedad o lluvia.

DK **N.B.** Det anbefales at udføre installation eller vedligeholdelse inden i den optiske enhed indenfor på et område fri for fugt og regn.

N **N.B.:** Det anbefales å utgjøre installasjons- eller vedlikeholdsinngrepene inne i det optiske rommet, innendørs eller i hvert fall der det ikek finnes fuktighet eller regn.

S **OBS!** Det rekommenderas att utföra installations- eller underhållsingrepp inuti det optiska rummet inomhus eller åtminstone i avsaknad av fukt eller regn..

RUS **ПРИМЕЧАНИЕ:** Рекомендуется выполнять монтаж или техническое обслуживание внутри лампового отсека в закрытых помещениях или по крайней мере в отсутствие влаги или атмосферных осадков.

CN 注释：建议在光学空间内部进行安装或者维修操作至少在内部环境或者不存在雨水或潮湿的环境

I Gli apparecchi sono stati progettati e collaudati per reggere un carico statico fino a 50000 N e resistere alle sollecitazioni di percorrenza. L'installazione non è ammessa in zone di utilizzo di spalaneve e con carrabilità a velocità superiori ai 50 Km/h.

GB The luminaries were designed and tested to withstand a static load of up to 50000 N and to resist drive-over stress. The luminaire may not be installed in areas where snowplows are used and where the drive-over speed exceeds 50 Km/h.

F Les appareils ont été spécialement conçus et testés pour supporter une charge statique pouvant atteindre 50000 N et résister aux contraintes de circulation. L'installation n'est pas permise dans des zones d'utilisation de chasse-neige et où la vitesse de circulation dépasse 50 Km/h.

D Bei der Entwicklung und Prüfung der Leuchten wurde sichergestellt, dass sie einer statischen Belastung von bis zu 50000 N sowie den Belastungen, denen sie auf viel befahrenen Straßen ausgesetzt sind, standhalten. Die Leuchten dürfen nicht in Bereichen installiert werden, in denen Schneeräumfahrzeuge eingesetzt werden, oder auf Straßen, die mit einer Geschwindigkeit von mehr als 50 km/h befahren werden.

NL De apparaten zijn ontworpen en goedgekeurd voor het verdragen van een statische lading tot aan 50000 N en het weerstaan van de druk van overgaand verkeer. Installeren in zones waar sneeuwploegen worden gebruikt en waar verkeer sneller dan 50Km/h passeert is niet toegestaan.

E Los aparatos fueron proyectados y probados para soportar una carga estática hasta de 50000 N y resistir a los esfuerzos derivados del tránsito. La instalación no está admitida en zonas donde se utilizan máquinas para espalar la nieve y donde esté permitido el tráfico a velocidades superiores a los 50 Km/h.

DK Armaturerne er udviklet og afprøvet til en statisk belastning på op til 50000 N og kan modstå forbipasserende belastninger. Installation er ikke tilladt i områder, hvor der kører sneplove og hvor der køres hurtigere end 50 km/t.

N Lysarmaturer ble designet og testet for å motstå en statisk belastning på inntil 50000 N og motstå overkjøringsbelastning. Armaturene kan ikke installeres i områder der det brukes snøploger, eller der overkjøringshastigheten overstiger 50 km/t.

S Utrustningarna har tillverkats och testats för att tåla en statisk belastning på upp till 5 000 N och tåla förbipasserande belastningar. Installationen är inte tillåten i områden där snöplog används eller där fordon passerar med en hastighet över 50 km/h.

RUS Приборы спроектированы и испытаны на статическую нагрузку вплоть до 50000 N кг и выдерживают динамичную нагрузку. Не допускается монтаж в зонах работы снегоуборочных машин и в зонах движения автотранспорта со скоростью выше 50 км/час.

CN 这些装置经过设计并且核查是可以承担最大重量至50000 N公斤的,并且能够承受路面载荷。在铲雪车经过以及通车速度时速超过50公里/小时的地方不可以安装。

Art.	...°C	Art.	...°C
B003 - B004 - B030 B225 - B226 - B242	50	**B014 - B015 - B231 B232**	45
B005 - B006 - B010 B013 - B227 - B228 B245 - B248	65	**B016 - B017 - B028 B233 - B234 - B240**	55
B007 - B008 - B024 B025 - B029 - B229 B230 - B241 - B251 B252	75	**B020 - B237**	85
B009 - B018 - B019 B235 - B236 - B244	60	**B021 - B238**	95
B011 - B022 - B026 B027 - B239 - B246 B249 - B253	70	**B023 - B250**	130
B012 - B247	80	**B031 - B243**	90

I Il simbolo identifica la temperatura massima del vetro. Tale valore, in funzione delle differenti sorgenti luminose, nella maggior parte dei casi è ampiamente inferiore a 75°C, come previsto dalle norme di sicurezza.

GB The symbol indicates the maximum temperature of the glass. In the majority of cases this value, depending on the different light sources, is substantially less than 75°C, as foreseen by the safety norms.

F Le symbole indique la température maxi. du verre. Cette valeur, selon les différentes sources lumineuses, est la plupart du temps largement inférieure à 75°C, comme prévu par les normes de sécurité.

D Das Symbol gibt die Höchsttemperatur des Glases an. Sie liegt meist, je nach verwendeter Lichtquelle, weit unter 75°C und entspricht somit den geltenden Sicherheitsnormen.

NL Het symbool identificeert de maximum temperatuur van de glasplaat . Deze waarde, naar gelang de verschillende lichtbronnen, is in de meeste gevallen ruim minder dan 75°C, zoals voorgeschreven door de veiligheidsnormen.

E El símbolo identifica la temperatura máxima del vidrio. Dicho valor, depende de las diferentes fuentes luminosas, pero en la mayor parte de los casos es ampliamente inferior a 75°C, de acuerdo con lo previsto por las normas de seguridad.

DK Symbolet angiver glassets maksimale temperatur. Denne værdi er, alt efter de forskelligelyskilder, i de fleste tilfælde et godt stykke under 75°C, som foreskrevet af sikkerhedsreglerne.

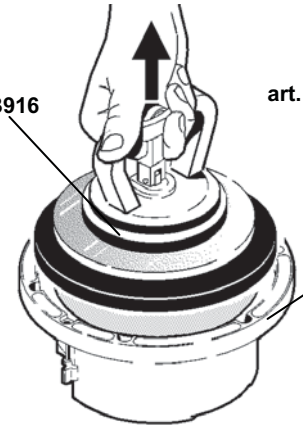
N Symbolet indikerer maksimal temperatur på glasset. I de fleste tilfeller er denne verdien, avhengig av de ulike lyskildene, avgjørende mindre enn 75°C, som stipulert av sikkerhetsstandarder.

S Symbolen anger glasets max. temperatur. Beroende på typen av ljuskälla är detta värde i de flesta fall långt under 75 °C, enligt gällande säkerhetsföreskrifter.

RUS Символ означает максимальную температуру стекла. Это значение, в зависимости от различных источников света, в основном значительно ниже 75°C согласно правилам безопасности.

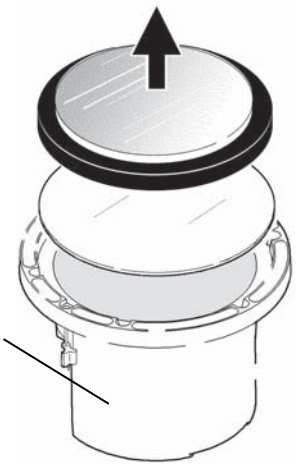
CN 此标志用来辨别玻璃的最高温度。此数值，根据不同的光源，大部分情况是远远低于75°C，就像安全规则上预计的一样。

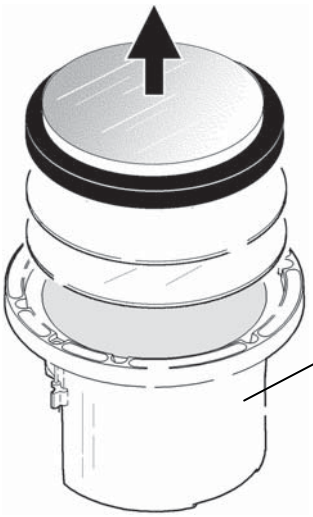
ART.	CONTROCASSA - OUTER CASING - BOÎTIER D'ENCASTREMENT EINBAUGEHÄUSE - INBOUWDOOS - CUERPO DE EMPOTRAMIENTO - BEHOLDER - HUS - HÖLJE МОНТАЖНЫЙ КОРПУС 外壳 **art.**							
	B901	**B902**	**B903**	**B904**	**B905**	**B906**	**B907**	**B908**
B003 - B225	●							
B004 - B226	●							
B005 - B227	●							
B006 - B228	●							
B007 - B229	●							
B008 - B230	●							
B009 - B244		●						
B010 - B245		●						
B011 - B246		●						
B012 - B247		●						
B013 - B248		●						
B014 - B231			●					
B015 - B232			●					
B016 - B233			●					
B017 - B234			●					
B018 - B235			●					
B019 - B236			●					
B020 - B237			●					
B021 - B238			●					
B022 - B249				●				
B023 - B250				●				
B024 - B251				●				
B025 - B252					●			
B026 - B253					●			
B027 - B239						●		
B028 - B240						●		
B029 - B241							●	
B030 - B242							●	
B031 - B243								●



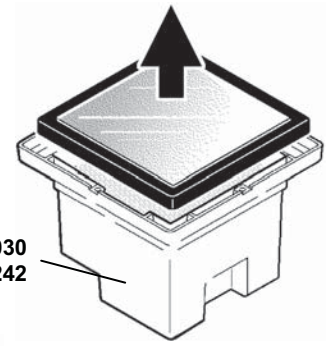
art. B003 - B004 - B005 B006 - B014 - B015 B016 - B017 - B018 B019 - B023 - B225 B226 - B227 - B228 B231 - B232 - B233 B234 - B235 - B236 B250

art. B007 - B008 - B009
B010 - B011 - B012
B020 - B021 - B022
B024 - B026 - B229
B230 - B237 - B238
B244 - B245 - B246
B247 - B249 - B251
B253

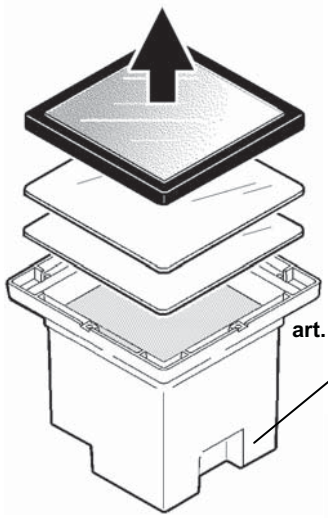




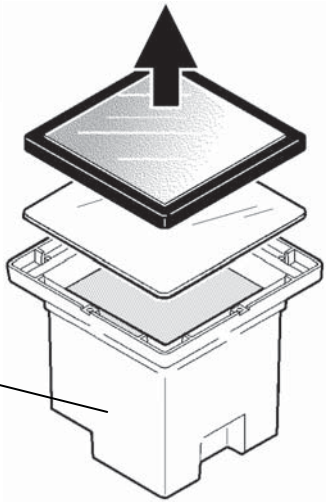
art. B013 - B025
B248 - B252



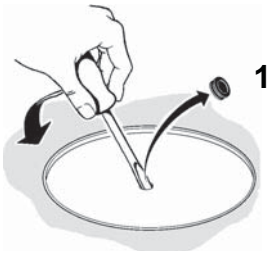
art. B028 - B030
B240 - B242



art. B029 - B031
B241 - B243



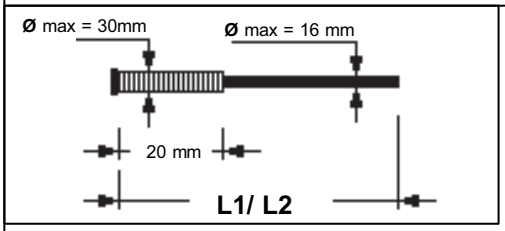
art. B027
B239

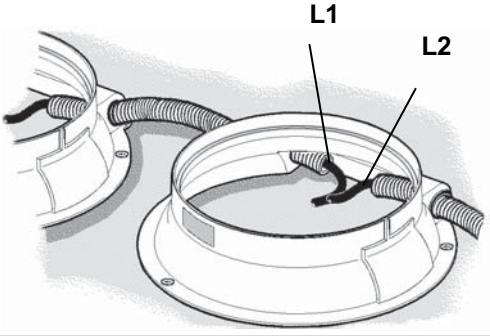


CABLAGGIO ELETTRICO
ELECTRIC WIRING
CABLAGE ÉLECTRIQUE
ELEKTRISCHE VERKABELUNG
DE ELEKTRISCHE INSTALLERING
CABLAJE ELÉCTRICO
ELEKTRISK LEDNINGSFØRING
ELEKTRISK KABLING
ELEKTRISK KABELDRAGNING
МОНТАЖ КАБЕЛЬНОЙ ПРОВОДКИ
布线

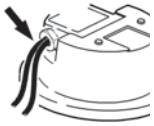
TIPO DI APPLICAZIONE TYPE OF APPLICATION TYPE D'APPLICATION ANWENDUNGSART HET SOORT VAN TOEPASSING TIPO DE APLICACIÓN ANVENDELSESOMRÅDE BRUKSOMRÅDE TYP AV ANVÄNDNING НАЗНАЧЕНИЕ 适用类型	TIPO CAVO - TYPE OF CABLE TYPE CÂBLE - KABELTYP TYPE KABEL - TIPO CABLE-LEDNINGSTYPE - TYPE KABEL-KABELTYP- ТИП ПРОВОДА - 电缆种类	
	SIGLA-ABBREVIATION SIGLE-ABKÜRZUNG CODENUMMER-SIGLA- SYMBOL-FORKORTELSE - FÖRKORTNING- ОБОЗНАЧЕНИЕ - 缩写	Sezione-Section Section-Querschnitt Doorsnede-Sección-Snit- Tverrsnitt-Tvärsnitt Сечение- 部分 (mm²)
ESTERNA	FG7OR	2 x 1,5
OUTDOOR		2 x 2,5
EXTÉRIEURE		2 x 4*
AUßEN		3 x 1,5
BUITENKANT		3 x 2,5*
EXTERNA		3 x 4*

I (*): Non sottoporre a trazioni superiori agli 80 N.
GB (*): Do not subject to tugs greater than 80 N.
F (*): Ne pas soumettre à des tractions dépassant 80 N.
D (*): Vermeiden Sie eine Zugkraft von über 80 N.
NL (*): Onderwerp ze niet aan een tractie die hoger is dan 80 N.
E (*): No someter a tracciones superiores a 80 N.
DK (*): Forbindelsen må ikke udsættes for trækpåvirkninger på over 80 N.
N (*): Ikke utsett for drakrefter som er større enn 80 N.
S (*): Utsätt dem inte för dragkrafter över 80 N.
RUS (*):Не подвергать натяжению с усилием более 80 Н.
CN (*):请勿使其受大于的80N的拖曳力。





CONTROCASSA - OUTER CASING - BOÎTIER D'ENCASTREMENT - EINBAUGEHÄUSE - INBOUWDOOS CUERPO DE EMPOTRAMIENTO - BEHOLDER - HUS - HÖLJE МОНТАЖНЫЙ КОРПУС 外壳 **art.**	**L1** (mm)	**L2** (mm)
B901	480 ± 20	480 ± 20
B902	980 ± 20	980 ± 20
B903	630 ± 20	630 ± 20
B904	1030 ± 20	1030 ± 20
B905	1010 ± 20	1010 ± 20
B906	780 ± 20	780 ± 20
B907	1050 ± 20	1050 ± 20
B908	1010 ± 20	1010 ± 20



I Per esigenze di collaudo, il prodotto é stato munito dei cavi indicati in figura.
N.B.: Asportare tali cavi prima di effettuare il cablaggio del prodotto.

GB In order to test the product, it was fitted with the cables indicated in the figure .
N.B.: Remove these cables before wiring the product.

F Pour des nécessités d'essai, le produit est fourni avec les câbles indiqués dans la figure.
N.B.: Enlevez ces câbles avant d'effectuer le câblage du produit.

D Aufgrund von Prüfungserfordernissen wurde das Produkt mit den auf der Abbildung ersichtlichen Kabeln bestückt.
N.B.: Diese Kabel sind vor der Verkabelung des Produkts abzunehmen.

NL Zoals voor de keuring vereist is het product voorzien van de in de afbeelding aangegeven kabels.
N.B.: Verwijder deze voordat u het product gaat bedraden.

E Debido a exigencias de ensayo, el producto ha sido provisto de los cables indicados en la figura.
NOTA: Extraer dichos cables antes de realizar el cableo del producto.

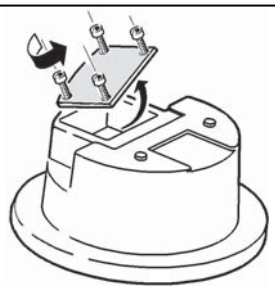
DK Med henblik på afprøvning er produktet forsynet med ledningerne, som vist i figuren.
N.B.: Disse ledninger skal fjernes, inden produktet tilsluttes.

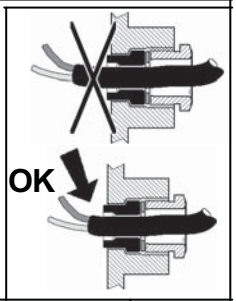
N For å kunne teste produktet, ble dette montert med kablene som indikeres på figuren.
N.B.: Fjern disse kablene før produktet installeres.

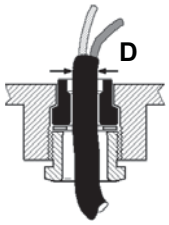
S På grund av provkörningsskäl har produkten försetts med kablarna som indikeras i figuren.
OBS! Ta bort dessa kablar innan ledningsdragningen för produkten görs.

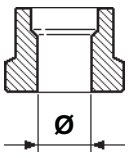
RUS Для тестирования прибор оснащен проводами, показанными на схеме.
ПРИМЕЧАНИЕ:Отсоедините эти провода перед монтажом кабелепроводки при бора.

CN 为检测产品，产品配备了图中所示的电缆。
注意，为产品配线前，拆掉这些电缆。

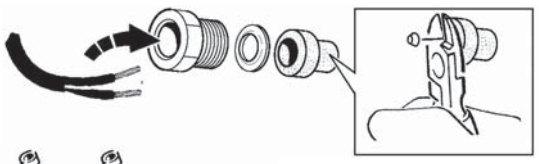


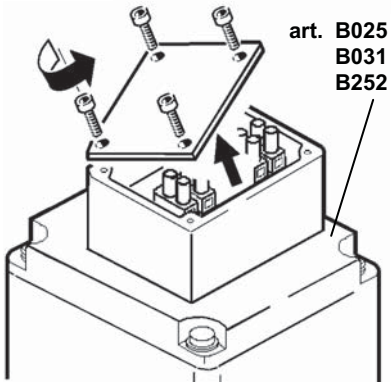


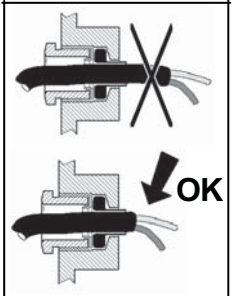


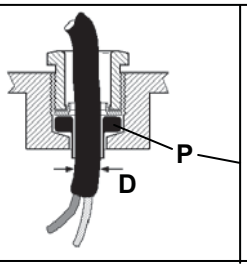


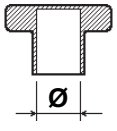
D (mm)	Ø (mm)
8,0 ÷ 10,0	8,5
10,0 ÷ 12,5	11
12,5 ÷ 14,5	13,5
14,5 ÷ 16,0	15,5



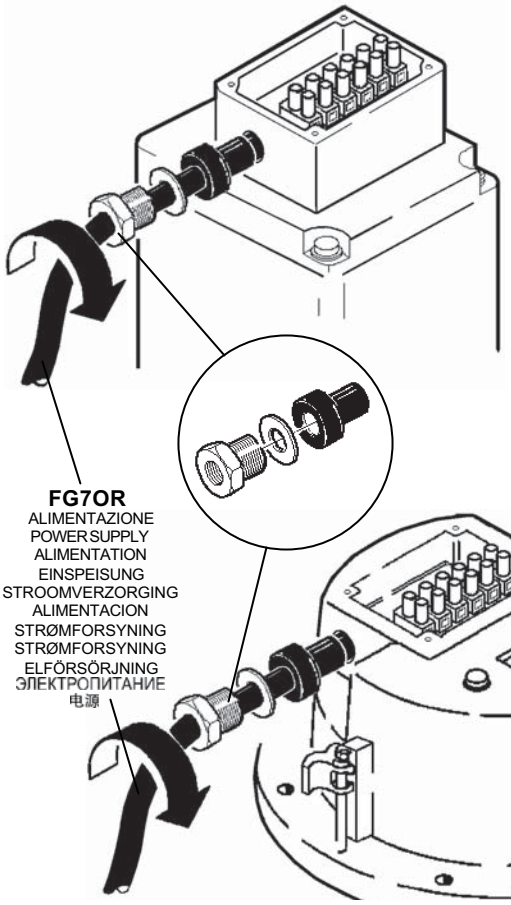


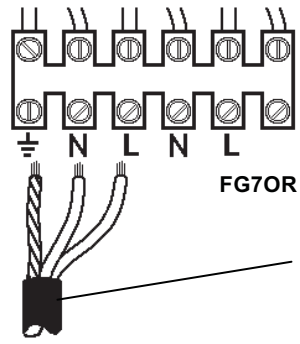


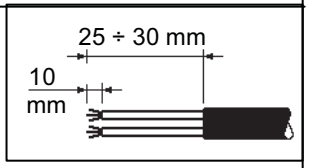


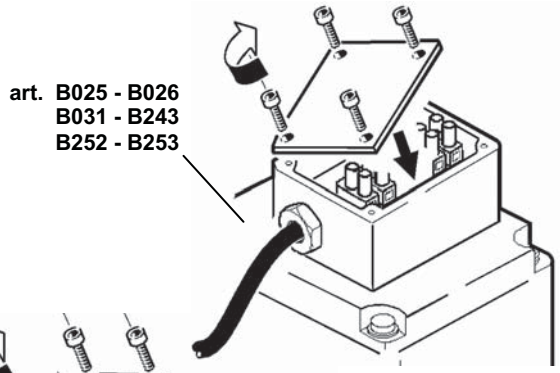


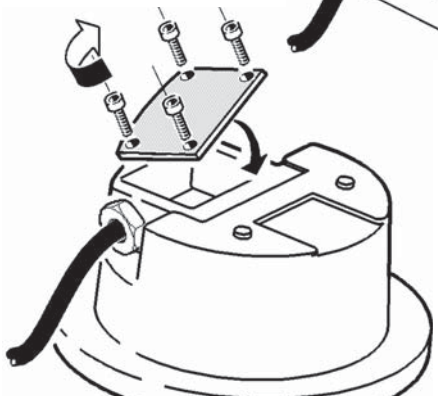
D (mm)	P Ø (mm)
6,5 ÷ 9,0	8,0
9,0 ÷ 11	10,5





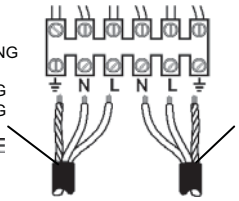






CABLAGGIO PASSANTE
FEEDTHROUGH WIRING
CABLAGE TRAVERSANT
DURCHGANGSKABEL
KABELDOORGANG
CABLEADO PASANTE
GENNEMGÅENDE LEDNINGER
FØRINGSKABLING
KABELGENOMFÖRING
СКВОЗНОЙ МОНТАЖ
连接线架设

ALIMENTAZIONE
POWER SUPPLY
ALIMENTATION
EINSPEISUNG
STROOMVERZORGING
ALIMENTACION
STRØMFORSYNING
STRØMFORSYNING
ELFÖRSÖRJNING
ЭЛЕКТРОПИТАНИЕ
电源

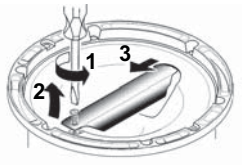


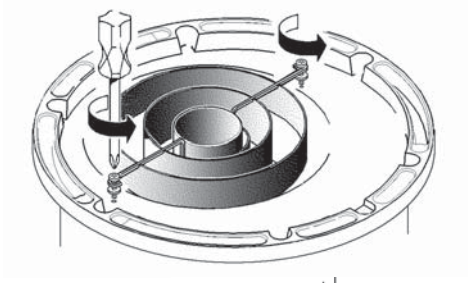
CABLAGGIO PASSANTE
FEEDTHROUGH WIRING
CABLAGE TRAVERSANT
DURCHGANGSKABEL
KABELDOORGANG
CABLEADO PASANTE
GENNEMGÅENDE
LEDNINGER
FØRINGSKABLING
KABELGENOMFÖRING
СКВОЗНОЙ МОНТАЖ
连接线架设

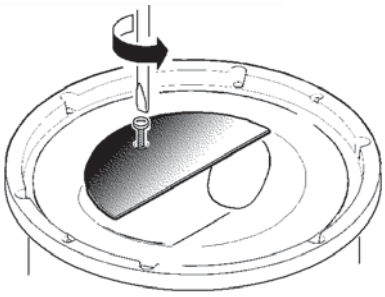
ART.	**N° Prodotti collegabili / Sezione cavo No. of products that can be connected / Cable cross section. Nombre de Produits reliables / Section câble Anzahl der Strahler, die miteinander verbunden werden können / Kabeldurchschnitt N° Verbindbare producten / Doorsnee kabel N° de productos a conectar / Sección del cable Antal produkter der kan tilsluttes / Kabelsnit Antall produkter som kan tilkoples / kabeltverrsnitt. Antal produkter som kan anslutas/kabeltvärsnitt Кол-во подсоединяемых приборов / Сечение провода 可连接的产品编号/电缆横截面**	
	1,5 mm²	2,5 mm²
B003 - B004 B225 - B226	107	147
B005 - B006 B227 - B228	140	192
B007 - B008 - B009 B011 - B229 - B230 B244 - B246	55	76
B010 - B016 - B017 B028 - B233 - B234 B240 - B245	46	68
B012 - B020 - B021 B022 - B026 - B027 B237 - B238 - B239 B247 - B249 - B253	32	43
B013 - B248	62	86
B014 - B015 B231 - B232	38	52
B018 - B019 - B030 B235 - B236 - B242	70	95
B023 - B025 - B029 B241 - B250 - B252	16	22
B024 - B251	23	31
B031 - B243	7	10

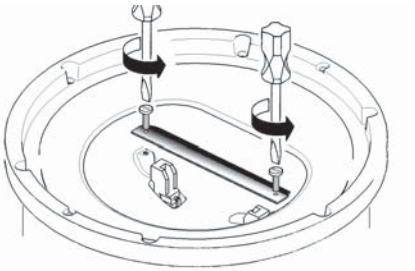
INSTALLAZIONE E SOSTITUZIONE DELLA LAMPADA
INSTALLING AND REPLACING THE LAMP
INSTALLATION ET REMPLACEMENT DE LA LAMPE
EINSETZEN UND AUSTAUSCHEN DER LEUCHTE
HET INSTALLEREN EN VERVANGEN VAN DE LAMP
INSTALACIÓN Y REEMPLAZO DEL FOCO
INSTALLATION OG UDSKIFTNING AF LYSKILDEN
INSTALLERE OG SKIFTE LAMPEN
INSTALLATION OCH BYTE AV LAMPA
МОНТАЖ И ЗАМЕНА ЛАМПЫ
安装和更换光源

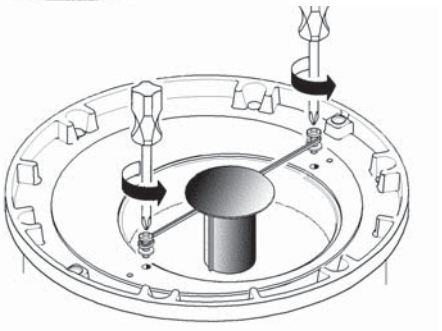
I N.B.: Installare o sostituire la lampada, senza graffiare il riflettore.
GB N.B.: Fit or replace the bulb, without scratching the reflector.
F N.B.: Installez ou remplacez la lampe, sans rayer le réflecteur.
D N.B.: Die Lampe installieren oder auswechseln, ohne den Reflektor zu verkratzen.
NL N.B.: Installeer of vervang de lamp zonder het afdeksoherm te krassen.
E NOTA: Instalar o sustituir la lámpara, sin aranar el reflector.
DK N.B.: Installér eller udskift lyskilden uden at ridse reflektoren.
N N.B.: Installer eller skift ut lampen uten å ripe reflektoren.
S OBS! Installera eller byt ut lampan utan att repa reflektorn.
RUS ПРИМЕЧАНИЕ: Устанавливайте или заменяйте лампу, стараясь не поцарапать отражатель.
CN 注意事项：安装或者更换灯泡，避免损坏反射镜。



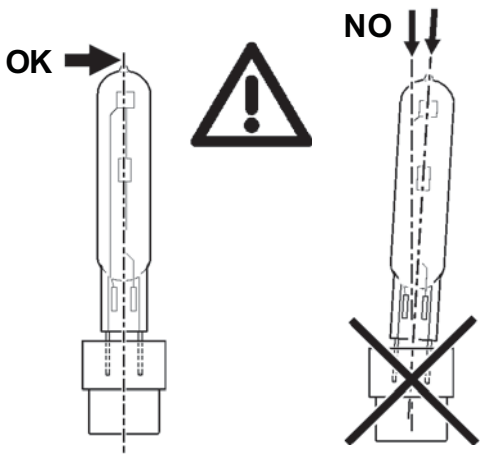






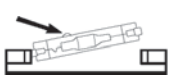


art. B005
B006
B227
B228



I Assicurarsi che l'asse della lampada e del portalampada coincidano.
GB Make sure the axis of the lamp corresponds with that of the lampholder.
F Veillez à ce que l'axe de la lampe et celui de la douille coïncident.
D Stellen Sie sicher, dass die Achse des Leuchtmittels mit der Achse der Lampenfassung übereinstimmt.
NL Verzekert u zich ervan dat de as van de lamp en van de lamphouder gelijkvallen.
E Asegurarse de que el eje de la lámpara y del portalámpara coincidan.
DK Kontroller, at lyskildens og fatningens akse er ud for hinanden.
N Se til at aksen på lampen tilsvarer den for lampeholderen.
S Försäkra dig om att lampan och lamphållaren är i linje.
RUS Проверьте, чтобы центральная линия лампы совпадала с центральной линией лампового патрона.
CN 确认灯座与灯泡的轴心相符合。

art. B020 - B021 - B027 - B029
B237 - B238 - B239 - B241



I Le condizioni ottimali di funzionamento della lampada sono garantite soltanto quando la tensione di alimentazione non supera del ± 5% la tensione nominale dell'apparecchio.

GB To ensure the total lamp efficiency, the mains voltage should not be more than ± 5% of the rated voltage of the fixture.

F En ce qui concerne le fonctionnement de la lampe, les conditions optimales ne sont assurées que si la tension d'alimentation ne dépasse pas de + ou – 5% la tension nominale de l'appareil.

D Die optimalen Funktionsbedingungen der Lampe sind nur dann gewährleistet, wenn die Anschlusspannung die Nennspannung des Gerätes nicht um ± 5% übersteigt.

NL De beste kondities voor het funktioneren van de lamp zijn slechts dan gegarandeerd als het voltage van de voeding niet hoger is dan ± 5% meer dan het nominale voltage van het apparaat.

E Las condiciones ideales de funcionamiento de la làmpara están garantizadas ùnicamente cuando la tensión de alimentación en red no sea mayor en un + o – 5%, con respecto a la tensión nominal del aparato.

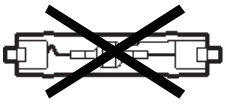
DK De optimale funktionsforhold for lyskilderne garanteres kun, hvis spændingen ikke overstiger ± 5 % af armaturets nominelle spænding.

N For å sikre total lampeeffektivitet, skal nettspenningen ikke være mer enn ± 5 % av nominell spenning på armaturen.

S Lampans optimala driftförhållanden garanteras endast när matningsspänningen inte överstiger ± 5 % av utrustningens nominella spänning.

RUS Оптимальные рабочие условия для лампы гарантируются только, если напряжение питания не превышает ± 5 % от номинального напряжения прибора.

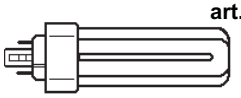
CN 为确保整灯效率，主电压的浮动不能超过装置规定值的± 5%。



art. B021
B238

OSRAM " HIT - TS "

art. B018 - B019 - B030
B235 - B236 - B242



OSRAM DELUX T/E 57W
PHILIPS MASTER PL-T 57W

art. B010
B245

OSRAM TC-TEL IN
PHILIPS MASTER PL-T 42W

art. B007 - B008 - B009 - B012 - B022
B023 - B025 - B229 - B230 - B244
B247 - B249 - B250 - B252

I **N.B.:** Assicurarsi che la lampada sia inserita nella sede del portalampada fino in fondo.

GB **N.B.:** Make sure that the lamp is properly inserted all the way into the lamp holder.

F **N.B.:** Assurez-vous que la lampe soit insérée à fond dans la douille.

D **N.B.:** Vergewissern Sie sich bitte, daß die Lampe fest in die Lampenhalterung eingeschraubt ist.

NL **N.B.:** Controleer dat de lamp goed is aangedraaid in de lamphouder.

E **NOTA:** Comprobar que la bombilla ha sido enroscada en el portalámparas hasta el tope.

DK **N.B.:** Kontroller, at lyskilden sidder korrekt i fatningen og er helt i bund.

N **N.B.:** Påse at lampen er riktig innsatt helt inn i lampeholderen.

S **OBS!** Försäkra dig om att lampan är insatt ordentligt i botten i lamphållarens säte.

RUS **ПРИМЕЧАНИЕ**:Проверьте, чтобы лампа была вставлена в гнездо лампового патрона до упора.

CN 注意：确保光源正确插入灯座。

I Il simbolo identifica gli apparecchi muniti di accenditore esterno alla lampada.
Non installare lampade con accenditore incorporato.

GB The symbol identifies luminaires fitted with an ignitor outside the lamp.
Do not install lamps with a built-in ignitor.

F Ce symbole identifie les appareils munis d'un amorceur externe à l'ampoule.
Ne pas installer d'ampoules avec amorceur incorporé.

D Mit diesem Symbol werden die Leuchten gekennzeichnet, deren Zündgerät sich außerhalb des Leuchtmittels befindet.
Bestücken Sie diese Leuchten nicht mit Leuchtmitteln mit eingebautem Zündgerät.

NL Het symbool identificeert de apparaten die zijn voorzien van een externe schakelaar van de lamp.
Installeer geen lampen met geïncorporeerde schakelaar.

E El símbolo identifica los aparatos provistos de encendedor externo a la lámpara.
No instalar lámparas con encendedor incorporado.

DK Symbolet angiver, at armaturet har en tænder, der er placeret uden for lyskilden.
Installer ikke lyskilder med indbygget tænder.

N Symbolet identifiserer lysarmaturer som har en tenning utenfor lampen.
Ikke installer lamper med innebygd tenning.

S Symbolen innebär att utrustningens lampa är försedd med extern tändare.
Montera inte lampor med inbyggd tändare.

RUS Эта маркировка обозначает приборы, укомплектованные внешним выключателем лампы.
Не устанавливать лампы со встроенным включателем.

CN 该符号定义为灯具适用独立触发器
勿安装自触发光源

I **N.B.:** Per eliminare eventuali formazioni di aloni sul vetro, utilizzare un panno morbido imbevuto di alcool.

GB **N.B.:** To prevent the formation of any marks on the glass, use a soft cloth soaked in alcohol.

F **N.B.:** Pour enlever toute trace sur le verre, utilisez un chiffon doux mouillé d'alcool.

D **N.B.:** Zum Entfernen von Halos, die sich möglicherweise auf dem Glas gebildet haben, verwenden Sie ein mit Alkohol getränktes Tuch.

NL **N.B.:** Voor het verwijderen van eventuele kringen op de glasplaat gebruikt u een zachte doek die met spiritus is bevochtigd.

E **NOTA:** Para eliminar las formaciones de halos en el vidrio, utilice un paño suave embebido en alcohol.

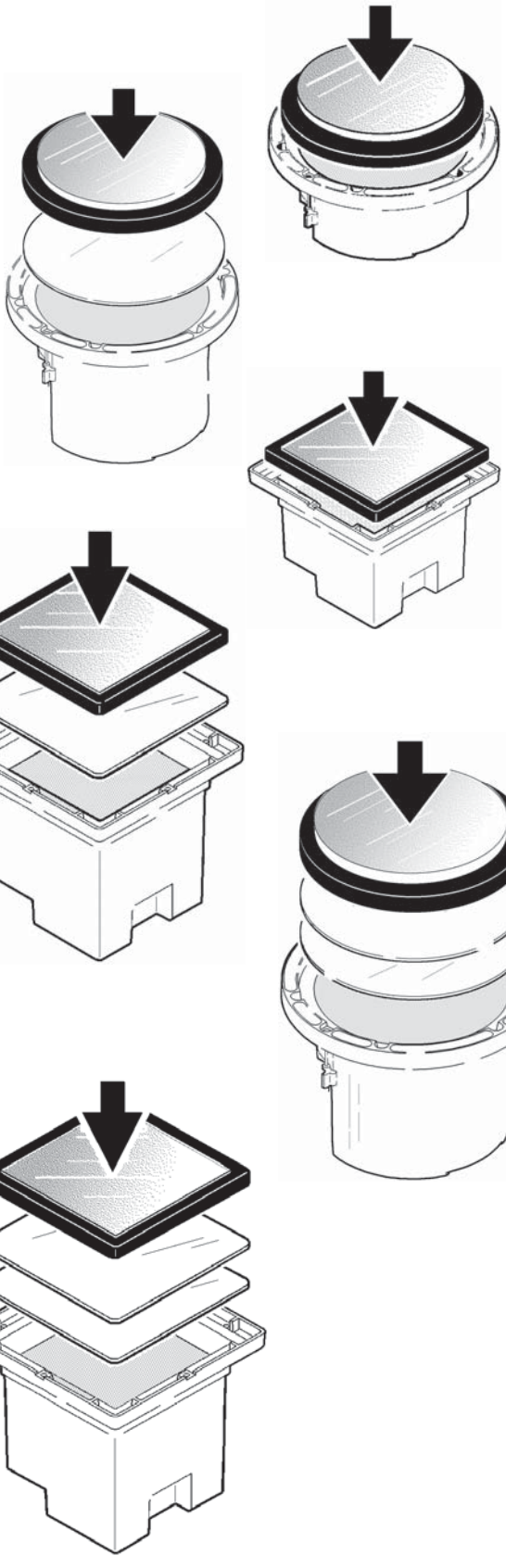
DK **N.B.:** For at fjerne halomærker på glasset skal bruge en blød klud opvædet i sprit.

N **N.B.:** For å forhindre dannelse av merker på glasset, bruk en myk klut fuktet med alkohol.

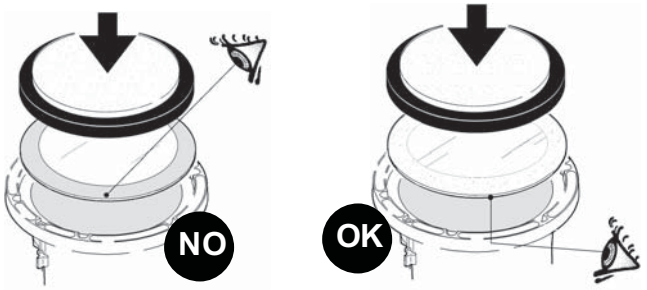
S **OBS!** Använd en mjuk trasa indränkt med alkohol för att ta bort eventuella fläckbildningar på glaset.

RUS **ПРИМЕЧАНИЕ:**Для удаления возможных разводов со стекла используйте мягкую тряпку, смоченную в спирте.

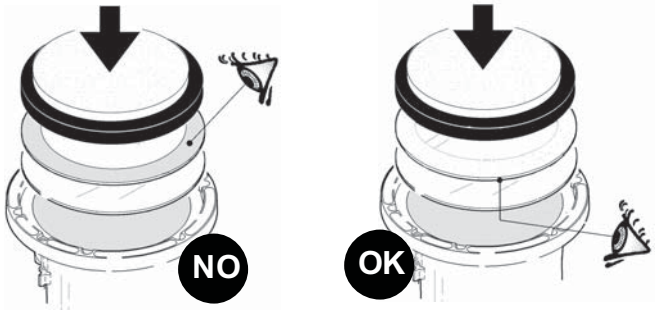
CN 注意：为了防止擦除玻璃表面的任何标志，请使用沾有酒精的柔软布块进行擦拭。



art. B009 - B010 - B011 - B012 - B013
B022 - B024 - B025 - B026 - B200
B201 - B202 - B203 - B204 - B244
B245 - B246 - B247 - B248 - B249
B251 - B252 - B253



art. B025 - B252



art. B003 - B004 - B005 - B006 - B007 - B008
B009 - B010 - B011 - B012 - B013 - B014
B015 - B016 - B017 - B018 - B019 - B020
B021 - B022 - B023 - B024 - B025 - B026
B027 - B028 - B029 - B030 - B031

I Prima di bloccare il vetro, accertarsi che esso sia centrato rispetto alla guarnizione.

GB Before fixing the glass, make sure it has been centred with respect to the gasket.

F Avant de bloquer le verre, contrôlez s'il est bien placé par rapport au joint.

D Bevor das Glas befestigt wird ist sicherzustellen, daß es mittig zur Dichtung aufgelegt wurde.

NL Voordat u de glasplaat vastzet moet u controleren of hij gecentreerd is ten opzichte van de afdichting.

E Antes de ajustar el cristal, verificar que haya sido centralizado con relación a la junta.

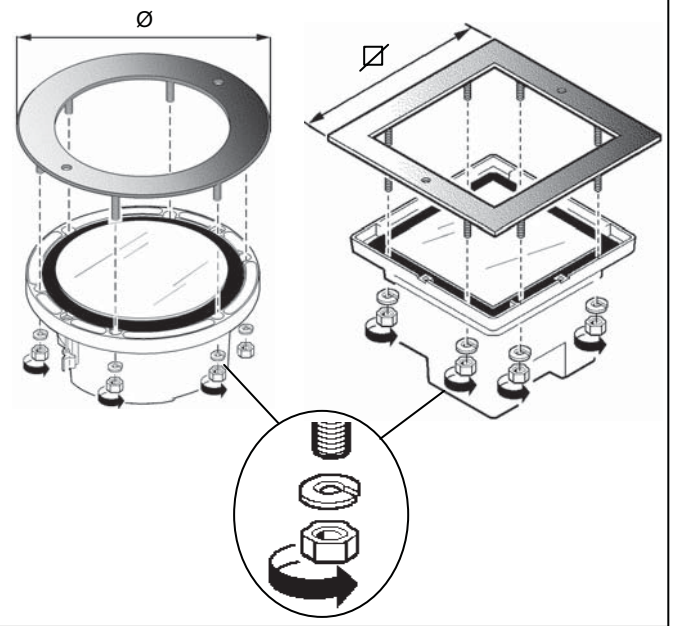
DK Inden glasset fastgøres skal man sikre sig, at det er centreret i forhold til pakningen.

N Før glasset festes, se til at det har blitt sentrert i forhold til pakningen.

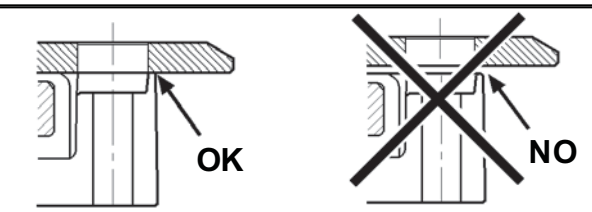
S Innan glaset låses fast ska du försäkra dig om att det sitter korrekt centrerat i förhållande till packningen.

RUS Перед креплением стекла проверьте, чтобы оно было отцентровано по отношению к уплотнению.

CN 固定玻璃前，确认玻璃已根据垫圈对中。



Nm	mm	
3 Nm	Ø 130	⊠ 130
5 Nm	Ø 312 ÷ 410	⊠ 346 ÷ 444



I N.B.: I dadi che fissano la cornice al corpo debbono essere serrati a fondo in modo uniforme, passando alternativamente da un dado a quello diametralmente opposto. Per facilitare l'estrazione del vetro senza danneggiare la guarnizione a cornice montata, svitare tutti i dadi ad esclusione di due consecutivi ed attendere; svitare poi i restanti dadi e togliere il vetro.

GB N.B.: The nuts that secure the frame to the body must be fully tightened in a uniform manner, alternating between diametrically opposed bol nuts. To facilitate the extraction of the glass without damaging the seal fitted onto the frame, unscrew all the nuts except for two adjacent ones and wait; then unscrew the remaining nuts and remove the glass.

F N.B.: Les écrous qui fixent le cadre au corps doivent être serrés à fond et de façon uniforme en passant alternativement d'un écrou à un autre diamétralement opposé. Pour simplifier l'extraction du verre sans endommager le joint quand le cadre est monté, dévissez tous les écrous sauf deux consécutifs, attendez puis dévissez les autres écrous et déposez le verre.

D N.B.: Die Schraubenmuttern, mit Hilfe derer der Rahmen am Leuchtenkörper befestigt wird, müssen gleichmäßig fest angezogen werden, wobei nach dem Anziehen eines Mutterns immer der diametral gegenüberliegende Bolzen anzuziehen ist. Um das Herausnehmen des Glases zu erleichtern und ein Beschädigen der Dichtung bei montiertem Rahmen zu verhindern, drehen Sie alle bis auf zwei benachbarte Schraubenmuttern heraus und warten Sie. Drehen Sie dann die restlichen Muttern heraus und entfernen Sie das Glas.

NL N.B.: De moeren die de lijst aan de romp bevestigen moeten gelijkmatig helemaal worden aangeschroefd, afwisselend gaande van de ene moer naar de andere bout die er diagonaal tegenover ligt. Voor het gemakkelijk verwijderen van de glasplaat zonder de afdichting te beschadigen, met de lijst gemonteerd, schroeft u alle moeren los behalve twee achter elkaar en wacht u; dan schroeft u de resterende moeren los en verwijdert u de glasplaat.

E Nota: Las turcas que fijan el marco al cuerpo se deben apretar a fondo de modo uniforme, pasando alternativamente de una turca a otro diametralmente opuesto. Una vez colocado el marco, para facilitar la extracción del vidrio sin dañar la junta, desenrosque todas las tuercas que no sean consecutivas y espere, desenrosque luego las tuercas restantes y quite el vidrio.

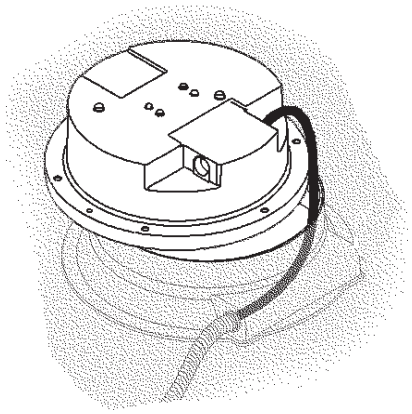
DK N.B.: Møtrikkerne, der fastgør rammen til legemet, skal skrues i bund på en ensartet måde, idet de strammes i diagonal rækkefølge. For at gøre udtrækning af glasset nemmere, uden at ødelægge pakningen på rammen, skal man løsne alle møtrikker på nær to tilstødende møtrikker og vente lidt og så løsne resten af møtrikkerne og tage glasset ud.

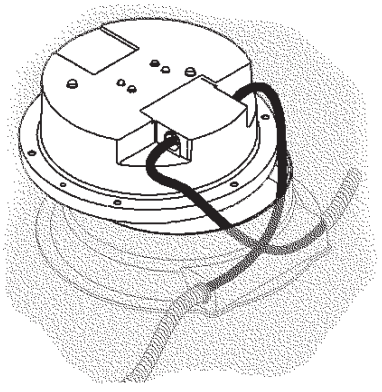
N N.B.: Mutrene som sikrer rammen til huset må være fullstendig tiltrukket på en jevn måte, ved å skifte mellom diametrisk motstående bolter. For å forenkle uttrekkingen av glasset uten å skade pakningen som sitter på rammen, skal alle mutrene, unntatt de to tilgrensende, skrus løs. Vent, og skru deretter løs de resterende mutrene og fjern glasset.

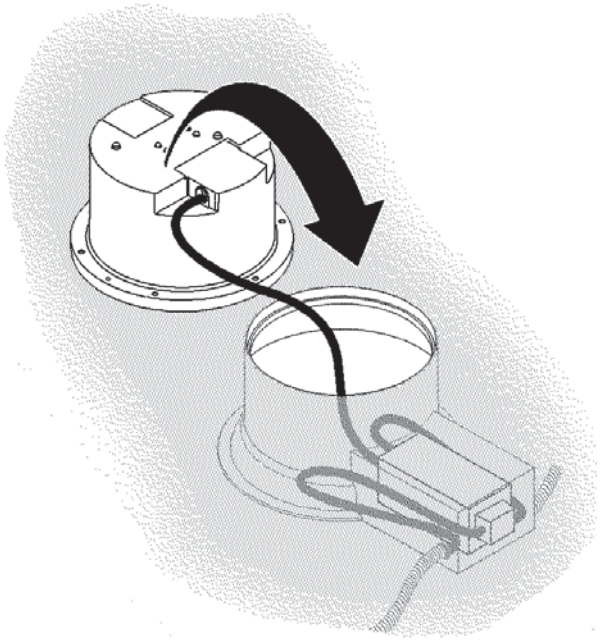
S OBS! Muttrarna som fäster ramen vid kroppen ska dras åt till botten på ett jämnt sätt genom att korsdras. För att underlätta utdragningen av glaset utan att skada packningen på den monterade ramen, skruva ur alla muttrar förutom de två som sitter i följd och vänta. Skruva sedan ur de sista muttrarna och ta bort glaset.

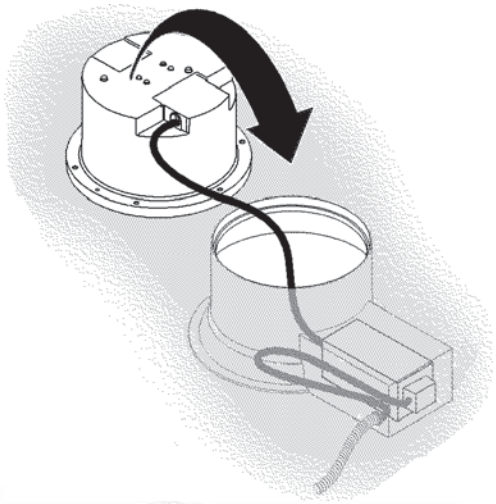
RUS ПРИМЕЧАНИЕ: Гайки, соединяющие рамку с корпусом, должны быть однородно закручены до упора, переходя от одной гайки к прямо противоположной. Для облегчения операции по съему стекла без риска повредить уплотнение с уже установленной рамкой отвинтите все гайки за исключением двух последовательных и подождите несколько секунд, затем отвинтите остальные гайки и выньте стекло.

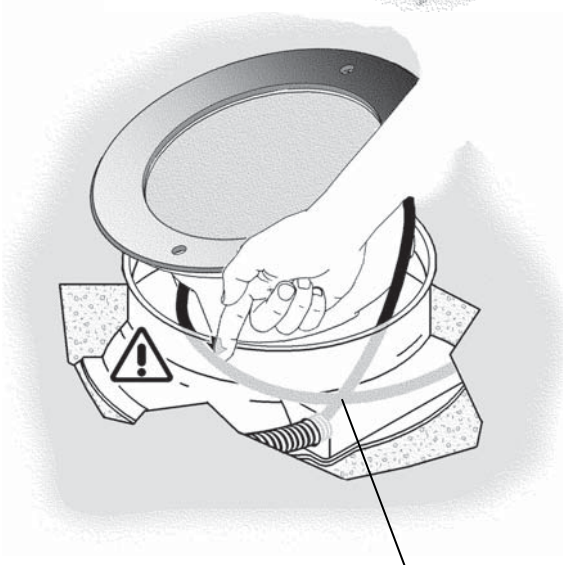
CN 注意事项：用来固定主体框架的螺钉应该均匀地拧紧至深处。为了方便地取出玻璃，但是又不损坏已经安装好的框架垫圈，小心谨慎拧开所有的螺钉，卸下玻璃。

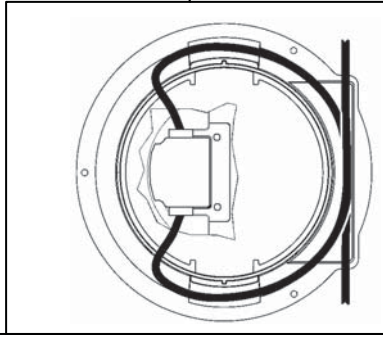






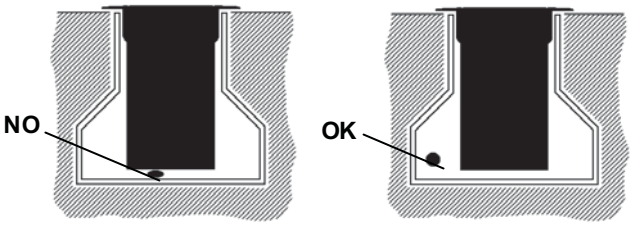




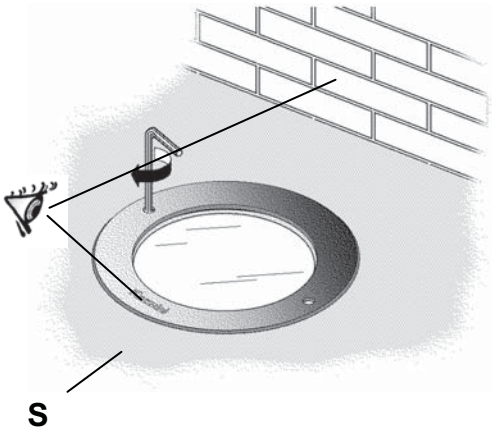


I Disporre i cavi ai lati dell'apparecchio come indicato in figura.
GB Arrange the cables on the sides of the luminaire as indicated in the figure.
F Placez les câbles sur les côtés de l'appareil comme illustré (voir figure).
D Ordnen Sie die Kabel wie in der Abbildung dargestellt an den Seiten der Leuchte an.
NL Plaats de kabels aan de zijkanten van het apparaat zoals aangegeven in de afbeelding.
E Coloque los cables a los costados del aparato como lo indica la figura.
DK Anbring ledningerne på siderne af armaturet, som vist i figuren.
N Plasser kablene på siden av lysarmaturen slik som indikert på figuren.
S Placera kablarna på utrustningens sidor, som visas i figuren.
RUS Расположите провода по бокам прибора, как показано на схеме.
CN 如图所示在灯具侧排列电缆.

art. B003 - B004 - B005 - B006 - B007
B008 - B014 - B015 - B016 - B017
B018 - B019 - B020 - B021 - B225
B226 - B227 - B228 - B229 - B230
B231 - B232 - B233 - B234 - B235
B236 - B237 - B238



DIREZIONE DA ILLUMINARE
DIRECTION OF LIGHT
DIRECATION A ECLAIRER
BELEUCHTUNGSRICHTUNG
TE VERLICHTEN RICHTING
DIRECCIÓN PARA ILUMINAR
RETNING, DER SKAL OPLYSES
LYSRETNING
RIKTNING OM SKA BELYSAS
НАПРАВЛЕНИЕ ОСВЕЩЕНИЯ
光照方向



I Accertarsi che l'area "**S**" sulla quale poggierà la cornice non presenti sporgenze.

GB Make sure area "**S**" onto which the frame will rest is free of any projections.

F Contrôlez que la zone "**S**" sur laquelle reposera le cadre ne présente pas d'aspérités.

D Vergewissern Sie sich, dass der Bereich "**S**", also die Stelle, wo der Rahmen aufgelegt wird, keine Unebenheiten aufweist.

NL Let op dat de zone "**S**" waarop de lijst zal rusten geen uitsteeksels vertoont.

E Asegurarse de que el área "**S**", sobre la que se apoyará el marco, no presente salientes.

DK Kontroller, at området "S", som kanten støtter mod, ikke rager ud nogen steder.

N Se til at området "S" der rammen skal hvile er fri for fremspring.

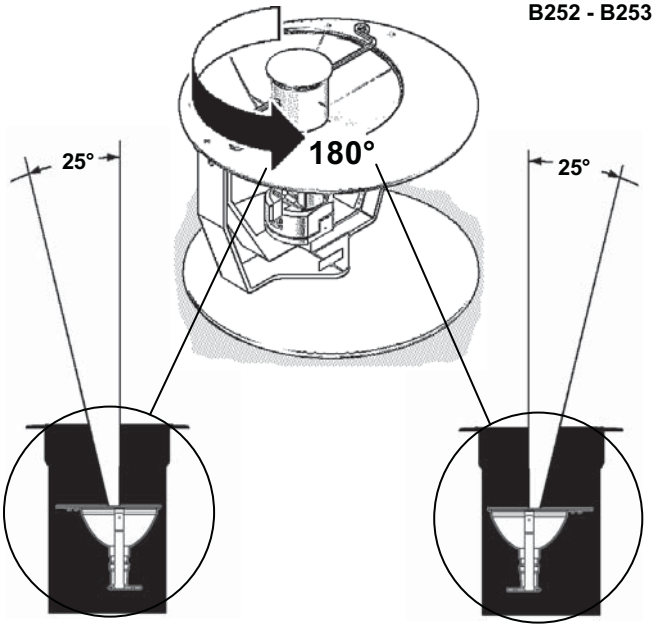
S Försäkra dig om att det inte finns några utstickande delar på området "S" där ramen vilar.

RUS Проверьте, чтобы площадь "S", на которую опирается рамка, не имела выступов.

CN 确保框架放置的"S"区域无任何照射.

ORIENTAMENTO DEL VANO OTTICO
ADJUSTING THE POSITION OF THE OPTICAL ASSEMBLY
ORIENTATION DU GROUPE OPTIQUE
AUSRICHTEN DES LAMPENANSCHLUSSES
HET RICHTEN VAN HET VERLICHTINGSARMATUUR
ORIENTABILIDAD DE LA OPTICA
INDSTILLING AF DEN OPTISKE ENHED
JUSTERING AV POSISJONEN PÅ DEN OPTISKE ENHETEN
RIKTNING AV OPTISKT RUM
ОРИЕНТАЦИЯ ЛАМПОВОГО ОТСЕКА
可调光的位置

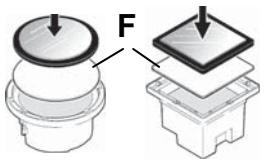
art. B009 - B010 - B011 - B012 - B013 - B022
B023 - B024 - B025 - B026 - B244 - B245
B246 - B247 - B248 - B249 - B250 - B251
B252 - B253



INSTALLAZIONE E SOSTITUZIONE DEL VETRO DI PROTEZIONE
INSTALLING AND REPLACING THE PROTECTION GLASS
INSTALLATION ET REMPLACEMENT DU VERRE DE PROTECTION
INSTALLATION UND AUSWECHSELN DES SCHUTZGLASES
HET INSTALLEREN EN VERVANGEN VAN HET PROTEKTIEGLAS
INSTALACION Y REEMPLAZO DEL CRISTAL DE PROTECCION
INSTALLATION OG UDSKIFTNING AF BESKYTTELSESGLAS
INSTALLERE OG SKIFTE UT BESKYTTELSESGLASSET
INSTALLATION OCH BYTE AV SKYDDSGLAS
УСТАНОВКА И ЗАМЕНА ЗАЩИТНОГО СТЕКЛА
防护玻璃的安装与拆卸

I In caso di rottura del vetro il prodotto non può essere utilizzato, contattare il costruttore per la sua sostituzione.
GB Should the glass break, the product cannot be used and you should contact the manufacturer for its replacement.
F En cas d'endommage de l'écran de protection le produit ne peut pas être utilizé, contactez le fabricant pour le remplacement.
D Falls das Glas kaputt sein sollte, kann das Produkt nicht verwendet werden. Kontaktieren Sie in dem Fall den Hersteller, um das Glas zu ersetzen.
NL Als het glas gebroken is kan het apparaat niet worden gebruikt en moet u zich tot de fabrikant wenden voor het vervangen van het glas.
E No utilizar el producto en caso de ruptura del vidrio y contactar el fabricante para la sustitución.
DK Hvis produktets glas ødelægges, kan det ikke anvendes. Kontakt forhandleren med henblik på udskiftning.
N Hvis glasset skulle knuses, kan ikke produktet brukes, og du må ta kontakt med produsenten for å få det skiftet.
S Om glaset går sönder kan inte produkten användas. Kontakta tillverkaren för att byta ut glaset.
RUS В случае разбивания стекла не используйте прибор, обратитесь к его производителю для замены.
CN 一旦玻璃破碎后产品将不能再使用，须联系生产商予以更换。

INSTALLAZIONE DEGLI ACCESSORI
INSTALLING THE ACCESSORIES
INSTALLATION DES ACCESSOIRES
INSTALLATION DER ZUBEHÖRTEILE
HET INSTALLEREN VAN DE ACCESSOIRES
INSTALACION DE ACCESORIOS
INSTALLATION AF TILBEHØR
INSTALLERING AV TILBEHØRET
INSTALLATION AV TILLBEHÖR
МОНТАЖ ВСПОМОГАТЕЛЬНЫХ КОМПЛЕКТУЮЩИХ
配件安装



ART.	Filtro - Filter-Filtre - Filter Filter - Filtro Filter - Filter - Filter Фильтр - 滤片 **'F"** art.	
B003 - B004 - B005- B006 - B007- B008 **B225 - B226 - B227 - B228 - B229 - B230**	B918	-
B009 - B010 - B011 - B012 - B013 **B244 - B245 - B246 - B247 - B248**		B922
B014 - B015 - B016 - B017 - B018 - B019 **B020 - B021 - B231 - B232 - B233 - B234** **B235 - B236 - B237 - B238**	B919	-
B022 - B024 - B025 - B026 **B249 - B251 - B252 - B253**		B923
B027 - B028 - B239 - B240	B920	-
B029 - B030 - B031 - B241 - B242 - B243	B921	-

I Posizionare la parte sabbiata del vetro verso la lampada.
GB Place the sand-blasted side of the glass towards the lamp.
F Positionnez la partie sablée du verre côté lampe.
D Das Glas wird mit der sandbestrahlten Seite zur Lichtqelle eingesetzt.
NL Plaats de gezandstraalde kant van de glasplaat naar de lamp toe.
E Coloque la parte arenada del vidrio hacia la lámpara.
DK Anbring glassets sandblæste del mod lyskilden.
N Plasser den sandblåse siden av glasset mot lampen.
S Placera glasets satinerade sida mot lampan.
RUS Матовая сторона стекла должна быть обращена к лампе.
CN 将玻璃磨沙的一面朝向灯泡放置。

I Il simbolo identifica gli apparecchi la cui tensione di picco, durante la sostituzione della lampada, supera i 34 Volts.

GB The symbol identifies luminaires whose peak voltage, during lamp replacement, exceeds 34 Volts.

F Ce symbole identifie les appareils dont la tension de crête, durant le remplacement de l'ampoule, dépasse les 34 volts.

D Mit diesem Symbol werden die Leuchten gekennzeichnet, deren Spitzenspannung während des Leuchtmittelwechsels mehr als 34 Volt beträgt.

NL Het symbool identificeert de apparaten waarvan de topspanning, gedurende het vervangen van de lamp, de 34 Volt overschreidt.

E El símbolo identifica los aparatos cuya tensión de pico supera 34 V durante la sustitución de la lámpara.

DK Symbolet betyder, at armaturets maksimale spænding, under udskiftning af lyskilden, overstiger 34 V.

N Symbolet identifiserer lysarmaturer med toppspenning som under lampeutskiftning overskrider 34 volt.

S Symbolen betecknar att utrustningens toppspänning under byte av lampa överstiger 34 Volt.

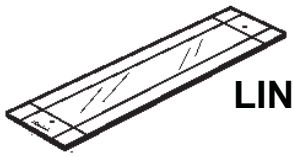
RUS Эта маркировка обозначает приборы, пиковое напряжение которых в процессе замены лампы, превышает 34 Вольт.

CN 该符号标明，这些灯具在更换光源时，光源的最大电压超过34伏。

Headquarters iGuzzini illuminazione spa
via Mariano Guzzini, 37 - 62019 Recanati Italy

1.154.288.05
IS00093/05

INSTALLATION INSTRUCTIONS
FIXTURE TYPE B



LINEALUCE

ATTENZIONE:
LA SICUREZZA DELL'APPARECCHIO E' GARANTITA SOLO CON L'USO APPROPRIATO DELLE SEGUENTI ISTRUZIONI; PERTANTO E' NECESSARIO CONSERVARLE.

WARNING:
THE SAFETY OF THIS FIXTURE IS GUARANTEED ONLY IF YOU COMPLY WITH THESE INSTRUCTIONS; REMEMBER TO CONSERVE IN A SAFE PLACE.

ATTENTION:
LA SECUTIE DE L'APPAREIL N'EST GARANTIE QU'EN CAS D'UTILISATION CORRECTE DES INSTRUCTIONS SUIVANTES; IL FAUT PAR CONSEQUENT LES CONSERVER.

ACHTUNG:
DIE SICHERHEIT DES GERÄTES WIRD NUR DURCH SACHGEMÄSSE BEFOLGUNG NACHSTEHENDER ANWEISUNGEN GEWÄHRLEISTET; IHRE AUFBEWAHRUNG IST DESHALB SEHR WICHTIG.

ATTENTIE:
DE VEILIGHEID VAN DE APPARATUUR IS SLECHTS DAN GEGARANDEERD ALS MEN DE VOLGENDE INSTRUKTIES STRIKT OPVOLGT: DAAROM MOET MEN ZE OOK BEWAREN.

ATENCION:
LA SEGURIDAD DEL APARATO SE GARANTIZA SOLO CUMPLIENDO CUIDADOSAMENTE LAS SIGUIENTES INSTRUCCIONES; POR ELLO, ES NECESARIO CONSERVARLAS.

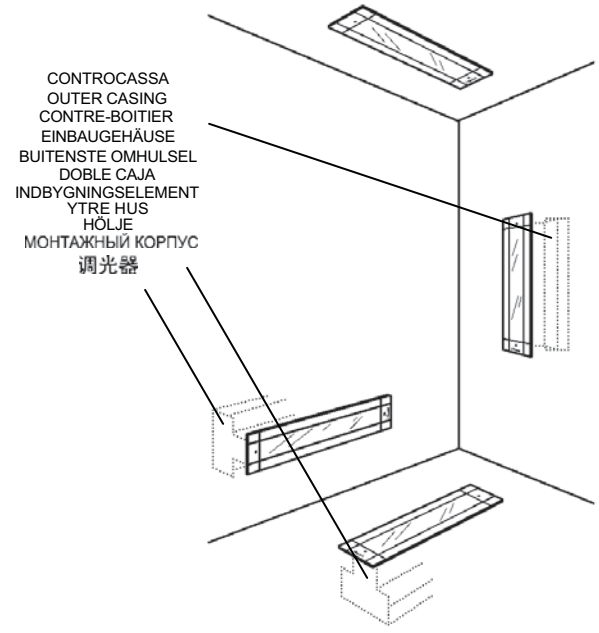
ADVARSEL:
SIKKERHEDEN VED BRUG AF ARMATURET KAN KUN GARANTERES, HVIS DISSE ANVISNINGER FØLGES; SØRG DERFOR FOR AT GEMME DEM.

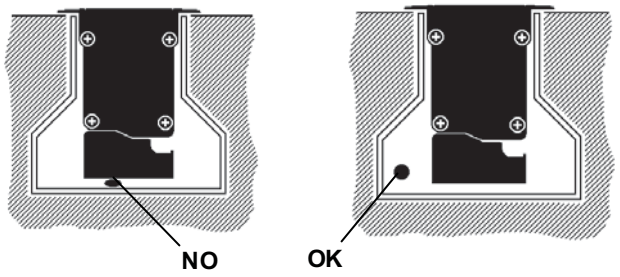
PAS PÅ:
SIKKERHETEN TIL DETTE APPARATET GARANTERES KUN HVIS DU OVERHOLDER DISSE INSTRUKSJONENE; HUSK Å OPPBEVARE DEM PÅ ET TRYGT STED.

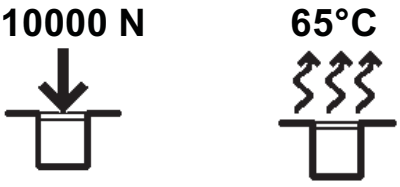
OBSERVERA!
UTRUSTNINGENS SÄKERHET KAN ENDAST GARANTERAS OM DESSA ANVISNINGAR RESPEKTERAS I DETALJ. SPARA DÄRFÖR DESSA ANVISNINGAR FÖR FRAMTIDA KONSULTATION.

ВНИМАНИЕ:
МЫ ГАРАНТИРУЕМ БЕЗОПАСНУЮ ЭКСПЛУАТАЦИЮ ИЗДЕЛИЯ ТОЛЬКО ПРИ СОБЛЮДЕНИИ СЛЕДУЮЩИХ ИНСТРУКЦИЙ; С ЭТОЙ ЦЕЛЬЮ НЕОБХОДИМО СОХРАНИТЬ ДАННУЮ БРОШЮРУ.

警告：
为确保该装置安全，请遵守操作指示；并于安全场所放置。







I Gli apparecchi sono stati progettati e collaudati per reggere un carico statico fino a 10000N (in funzione della controcassa), per installazioni in zone esclusivamente pedonali ciclabili, La bassa temperatura supeficiale (65°C),non crea limitazioni d'installazione.

GB The fittings have been designed and tested to withstand a static load of 10000 N (based on the outer casing) for installation exclusively in pedestrian or bicycle areas.
The low surface temperature (65°C) impose no limits on installation.

F Les appareils ont été spécialement conçus et testés pour supporter une charge statique pouvant atteindre 10000 N (en fonction de la boîte de réservation), pour l'installation dans des zones seulement piétonnes ou cyclables.
La température de surface réduite (65°C) ne pose aucune limitation d'installation.

D Bei der Entwicklung und Prüfung der Leuchten wurde sichergestellt, dass sie einer statischen Belastung von bis zu 10000 N standhalten - je nach Einbaugehäuse; damit eignen sie sich ausschließlich zur Installation auf Geh- oder Fahrradwegen.
Dank der niederen Temperatur der Kontaktflächen (65°C) sind bei der Installation keine diesbezüglichen Einschränkungen gegeben.

NL De apparaten zijn ontworpen en goedgekeurd voor het dragen van een statische lading tot aan 10000 N (met betrekking tot de inbouwdoos) voor installaties in gebieden die alleen door voetgangers of fietsers worden begaan.
De lage oppervlaktetemperatuur (65°C) hoeft geen beperking voor de installatie te vormen.

E Los aparatos han sido diseñados y ensayados para resistir una carga estática de 10000 N (en función del cuerpo de empotramiento), para instalaciones exclusivamente en zonas para peatones o bicicletas.
La baja temperatura superficial 65°C) no impone limitaciones de instalación.

DK Armaturerne er udviklet og afprøvet til en statisk belastning på op til 10000 N (alt efter indbygningselementet) til installationer udelukkende på fortove eller på cykelstier. Den lave overfladetemperatur (65° C) gør, at der ikke er nogen begrænsninger ved installationen.

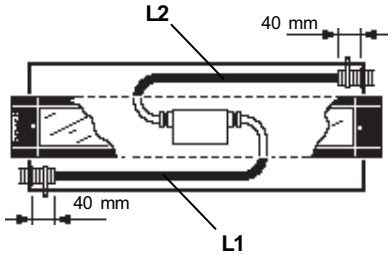
N Monteringene har blitt designet og testet for å motstå en statisk belastning på 10000 N (basert på det ytre huset) for installasjon utelukkende i gang- eller sykkelområder.
Den lave overflatetemperaturen 65°C) gir ingen begrensninger for installasjonen.

S Utrustningen är konstruerad och testad för att tåla en statisk belastning på upp till 1 0000 N (beroende på höljet) och ska endast installeras i områden med gågator eller cykelvägar.
Den låga yttemperaturen (65 °C) ger inga installationsbegränsningar.

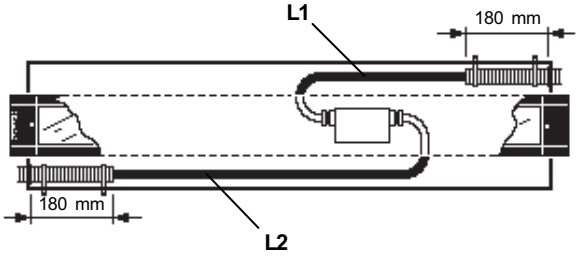
RUS Приборы были спроектированы и испытаны на статическую нагрузку вплоть до10000 N (в зависимости от типа монтажного корпуса) для монтажа исключительно в пешеходных или велосипедных зонах.
Низкая температура поверхности (°C) не требует никаких ограничений по установке.

CN 此配件经设计和测试可以经受 10000 N 公斤（基于外壳）的静载重，仅适用于安装在步行或自行车行驶区域。
低表面温度（ 65 摄氏度）对于安装无利用限制。

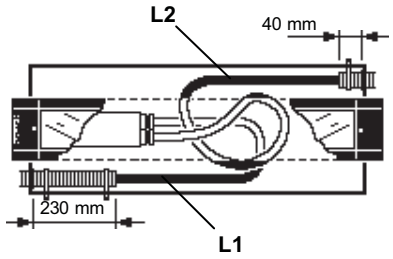
art. 7878



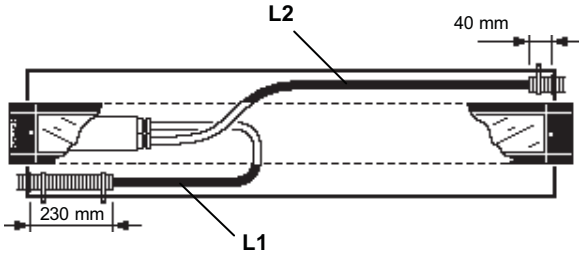
art. 7879 - 7880 - 7881 - 7882
7890 - 7891 - 7892 - 7893



art. 7883

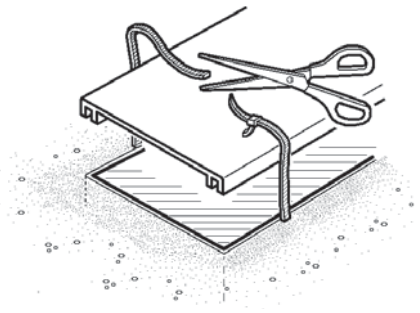


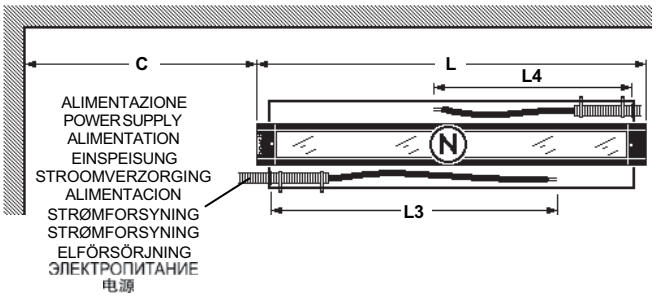
art. 7884 - 7885 - 7886 - 7887 - 7888 - 7889



ART.	Controcassa - Outer Casing Contre-boitier - Einbaugehäuse Buitenste Omhulsel - Doble Caja- INDBYGNINGSELEMENT-YTRE HUS HÖLJE- МОНТАЖНЫЙ КОРПУС - 调光器 ART.	L1 (mm)	L2 (mm)
7878	5901	530	530
7879	5902	790	790
7880	5903	790	990
7881	5904	790	1190
7882	5905	790	1440
7883	5906	380	470
7884	5907	480	460
7885	5908	480	620
7886	5909	480	750
7887	5910	480	920
7888	5911	480	1040
7889	5912	480	1200
7890	5902	790	790
7891	5903	790	990
7892	5904	790	1190
7893	5905	790	1440

I Disporre i cavi ai lati del modulo come indicato in figura. Le lunghezze **"L1"** ed **"L2"** indicate in tabella, sono comprensive del tratto di cavo interno al tubo corrugato.
GB Place the cables on the sides of the module as indicated in the figure. Lengths **"L1"** and **"L2"** indicated in the table include the portion of the cables on the inside of the corrugated tube.
F Disposez les câbles sur les côtés du module comme illustré (voir figure). Les longueurs **"L1"** et **"L2"** indiquées au tableau comprennent la portion de câble à l'intérieur de la gaine.
D Bringen Sie die Kabel der Abbildung entsprechend am Modul an. Die in der Tabelle angegebenen Längen **"L1"** und **"L2"** schließen das Kabelstücks, das sich innerhalb der geripptен Röhre befindet, mit ein.
NL Plaats de draden aan de zijkanten van het armatuur zoals aangegeven in de afbeelding. De lengten **"L1"** en "**L2**" in de tabel zijn inclusief het stuk draad binnenin de geribte buis.
E Disponer los cables a los lados del módulo, tal y como se indica en la figura. Las longitudes **"L1"** y **"L2"** indicadas en la tabla comprenden el tramo de cable interno del tubo arrugado.
DK Placere kablene langs modulens sider som angitt i figuren. Lengdene **"L1"** og **"L2"** somangis i tabellen iberegner kabelstykket inne i slangen.
N Anbring ledningerne på siderne af modulet, som vist i figuren. Længderne **"L1"** og **"L2"**, som angivet i tabellen, omfatter den del af ledningen, der er inden i røret.
S Placera kablarna på produktens sidor, som indikeras i figuren. Längderna **L1** och **L2** som anges i tabellen inbegriper kabelpartiet inuti det korrugerade röret.
RUS Расположите провода по бокам модуля, как показано на схеме. Длина "L1" и "L2", указанная в таблице, включает в себя отрезок внутреннего провода до гофрированной трубы.
CN 按照图表把电缆定位在灯具两侧。图表指示的**"L1"** 及**"L2"** 的长度包括熔皱管道内的电缆部分。



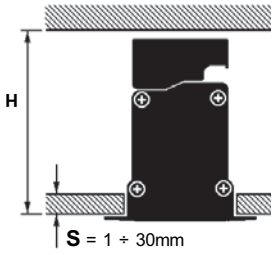


I Se la distanza **"C"** dalla parete è minore della lunghezza **"L"** e l'alimentazione proviene da sinistra, i cavi **"L1"** ed **"L2"** del modulo **"N"** vanno allungati come indicato dalla tabella seguente.
GB If the distance **"C"** from the wall is less than length **"L"** and the power supply comes from the left, cables **"L1"** and **"L2"** of module **"N"** should be lengthened as shown in the figure.
F Si la distance **"C"** du mur est inférieure à la longueur **"L"** et il y a alimentation par la gauche, les câbles **"L1"** et **"L2"** du module **"N"** doivent être allongés comme indiqué par le tableau suivant.
D Sollte der Absand **"C"** von der Wand geringer als **"L"** sein und die Stromversorgung von links kommen, dann sind die Kabel **"L1"** und **"L2"** des Moduls **"N"** den Angaben folgender Tabelle entsprechend zu verlängern.
NL Als de afstand **"C"** vanaf de wand kleiner is dan de lengte **"L"** en de stroomvoorziening komt van links, dan moeten de draden **"L1"** en **"L2"** van het armatuur **"N"** verlengd worden zoals aangegeven in de volgende tabel.
E Si la distancia **"C"** desde la pared es menor que la longitud **"L"** y la alimentación procede de la izquierda, los cables **"L1"** y **"L2"** del módulo **"N"** se deben prolongar, tal y como se indica en la siguiente tabla.
DK Hvis afstanden **"C"** fra væggen er mindre end længden **"L"** og strømforsyningen kommer fra venstre, skal ledningerne **"L1"** og **"L2"** i modulet **"N"** forlænges, som vist i følgende tabel.
N Hvis avstanden **"C"** fra veggen er mindre enn lengden **"L"** og strømtilførselen kommer fra venstre, skal kablene **"L1"** og **"L2"** til modulen **"N"** forlenges som angitt i følgende tabell.
S Om avståndet **C** från väggen är kortare än längden L och elförsörjningen kommer från vänster, ska kablarna **L1** och **L2** för modulen **N** förlängas enligt följande tabell.
RUS Если расстояние "C" от стены меньше длины "L", и сетевой кабель подходит слева, провода "L1" и "L2" модуля «N» должны быть удлинены, как показано в таблице ниже.
CN 如果与墙壁的距离**"C"**比**"L"**长度小并且电源线从左面过来，就必须把灯具**"N"**的**"L1"**及**"L2"**电缆按照下列的图表加长。

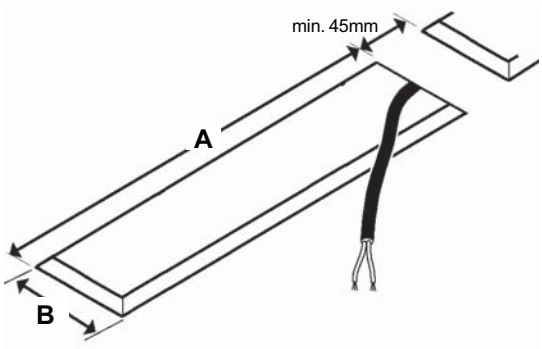
ART.	L3 (mm)	L4 (mm)
7878	530	530
7879	800	800
7880	1500	1000
7881	1800	1200
7882	2100	1450
7883	380	470
7884	860	690
7885	1080	740
7886	1260	750
7887	1460	910
7888	1540	1040
7889	1680	1200
7890	800	800
7891	1500	1000
7892	1800	1200
7893	2100	1450

INSTALLAZIONE SUL CONTROSOFFITTO
INSTALLATION ON CEILING
INSTALLATION AU FAUX-PLAFOND
INSTALLATION AN DER HÄNGEDECKE
HET INSTALLEREN IN HET VERLAAGDE PLAFOND
INSTALACION SOBRE FALSO TECHO
INSTALLATION PÅ FORSÆNKET LOFT
MONTERING I TAKET
INSTALLATION I UNDERTAK
МОНТАЖ В ФАЛЬШ-ПОТОЛКЕ
吸顶式安装天花板上的安装

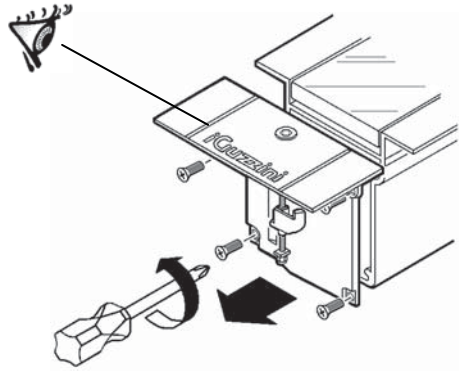
I Nell'installazione a soffitto, ancorare i due cavetti d'acciaio art. **5926** alla struttura portante del controsoffitto.
GB For ceiling installations, anchor the two steel wires art. **5926** to the carrying structure of the false ceiling.
F En cas d'installation au plafond, ancrez les deux filins en acier art. **5926** à la structure portante du faux plafond.
D Bei der Deckeninstallation sind die beiden Stahlseile, Art. **5926**, an der Trägerstruktur der Hängedecke zu befestigen.
NL Bij installatie aan het plafond moeten er twee stalen draden art. **5926** aan de draagstructuur van het verlaagde plafond worden bevestigd.
E En la instalación en el techo, anclar los dos cables de acero art. **5926** a la estructura portante del cielo falso.
DK Ved installation i loftet, skal man fastgøre de to stålkabler art. **5926** i den bærende struktur i det forsænkede loft.
N For takinstallasjoner skal de to ståltauene art. **5926** forankres til bærestrukturen på hengetaket.
S Vid montering i taket, fäst de två ståltrådarna art. **5926** i takets bärande struktur.
RUS При монтаже на потолке прикрепите два стальных троса арт. 5926 к несущей структуре фальш-потолка.
CN 安装天花板时，将此两根钢缆art. 5926固定在假天花的龙骨结构上。



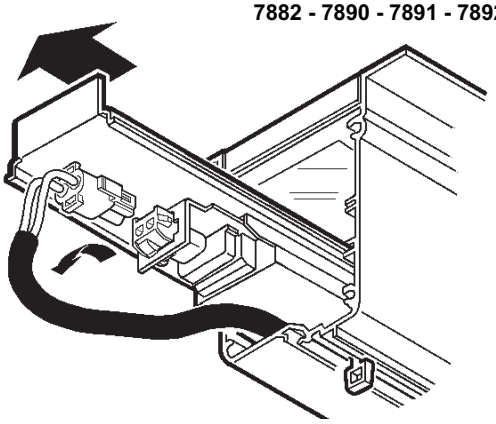
ART.	A (mm)	B (mm)	H (mm)	PESO WEIGHT POIDS GEWICHT GEWICHT PESO VÆGT VEKT VIKT BEC 重量 (Kg)
7878	373	73	118	1,9
7879	627	73	118	3,1
7880	931	73	118	4,2
7881	1227	73	118	5,6
7882	1527	73	118	6,9
7883	419	73	136	2,5
7884	569	73	136	3,1
7885	729	73	136	3,8
7886	889	73	136	4,3
7887	1049	73	136	5,0
7888	1209	73	136	5,7
7889	1369	73	136	6,3
7890	627	73	118	3,1
7891	931	73	118	4,4
7892	1227	73	118	5,6
7893	1527	73	118	6,9

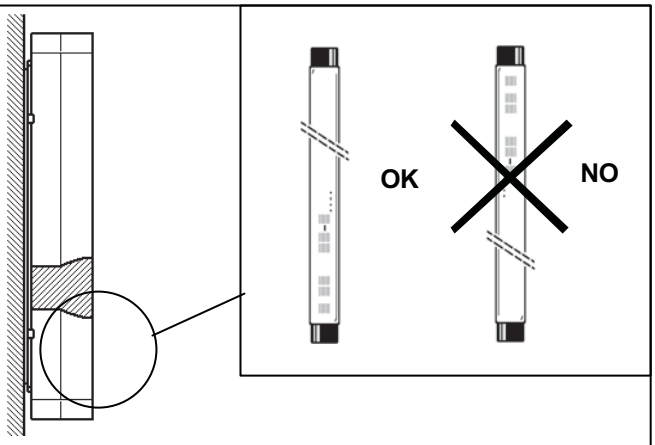


INSTALLAZIONE E SOSTITUZIONE DELLA LAMPADA
INSTALLING AND REPLACING THE LAMP
INSTALLATION ET REMPLACEMENT DE LA LAMPE
EINSETZEN UND AUSTAUSCHEN DER LEUCHTE
HET INSTALLEREN EN VERVANGEN VAN DE LAMP
INSTALACIÓN Y REEMPLAZO DEL FOCO
INSTALLATION OG UDSKIFTNING AF LYSKILDEN
INSTALLERE OG SKIFTE LAMPEN
INSTALLATION OCH BYTE AV LAMPA
МОНТАЖ И ЗАМЕНА ЛАМПЫ
安装和更换光源



art. 7878 - 7879 - 7880 - 7881
7882 - 7890 - 7891 - 7892 - 7893





art. L150

THHC LIGHTING
"RLC1285X"

I Le prestazioni fotometriche dichiarate a catalogo sono garantite usando le lampade indicate.

GB The photometric performance indicated in the catalogue is guaranteed when using the lampsshown.

F Les performances photométriques reportées dans notre catalogue ne sont atteintes qu'en montant les lampes indiquées.

D Die im Katalog angegeben photometrischen Leistungen werden bei Einsatz der veranschaulichten Lampen gewährleistet.

NL De in de catalogus vermeldde fotometrische prestaties worden gegarandeerd als de lampen worden gebruikt die zijn aangegeven.

E Las prestaciones fotométricas que declara el catálogo se garantizan al utilizar las lámparas indicadas.

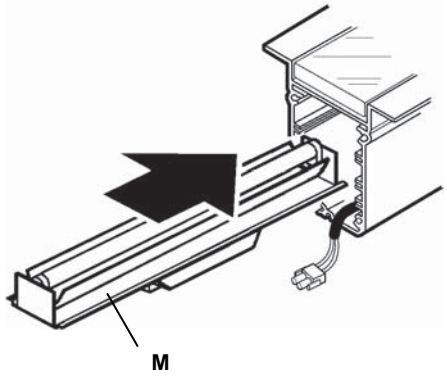
DK Den angivne lysnormale ydelse i kataloget garanteres, hvis man bruger de angivne pærer.

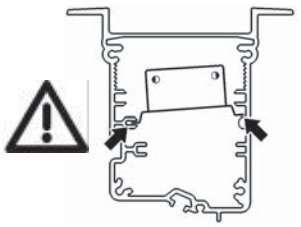
N Den fotometriske ytelsen som indikeres i katalogen garanteres ved bruk av viste lamper.

S Den fotometriska kapaciteten som uppges i katalogen garanteras under förutsättning att rekommenderadelamporanvänds.

RUS Фотометрические характеристики, указанные в каталоге, гарантируются в случае использования указанных ламп.

CN 只有使用目录指定的灯泡,光度效能值才能得到保证.





I Dopo aver installato la lampada, reinserire la montatura elettrica '**M**", avendo cura di centrarla rispetto al modulo.
N.B.: Reinserendo la montatura elettrica, evitare lo schiacciamento dei cavi passanti.

GB After having fitted on the lamp, reinsert the electrical assembly '**M**", taking care to centre it with respect to the module.
N.B.: When re-assembling the electric installation, try to avoid squashing the passing cables.

F Après avoir installé la lampe, remontez l'équipement électrique '**M**" en veillant à bien le centrer par rapport au module.
N.B.: Lors du remontage de l'installation électrique, veillez à ne pas écraser les câbles traversants.

D Nachdem Sie die Lampe eingesetzt haben, fügen Sie das Stromgestell '**M**" wieder ein; achten Sie dabei darauf, dass es genau in der Mitte der Leuchte positioniert wird.
N.B.: Achten Sie bei Wiedereinsetzen der Elektro-Fassung darauf, die Durchgangskabel nicht einzuklemmen.

NL Na het installeren van de lamp wordt de elektrische structuur '**M**" weer aangebracht, nauwkeurig in het midden van het armatuur.
N.B.: Als men het electrische montuur weer terugzet, moet men voorkomen dat de hier langs lopende kabels worden platgedrukt.

E Una vez instalada la lámpara, volver a insertar la estructura eléctrica '**M**" en posición central respecto al módulo.
NOTA: Al volver a introducir la montura eléctrica, evite el aplastamiento de los cables pasantes.

DK Efter at have installeret pæren, skal man genmontere det elektriske beslag "**M**" og sørge for, at det sidder centralt i forhold til modulet.
N.B.: Når det elektriske beslag genmonteres, skal man passe på, at de gennemgående ledninger ikke klemmes sammen.

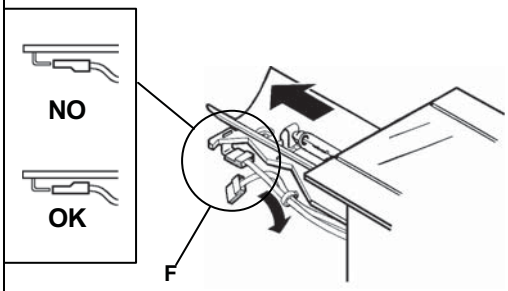
N Etter montering på lampen settes den elektriske monteringen "**M**" tilbake, se til å sentrere den i forhold til modulen.
N.B.: Prøv å unngå å klemme de passerende kablene ved remontering av den elektriske installasjonen.

S Sätt tillbaka den elektriska armaturen M efter att lampan har installerats. Var noga med att centrera armaturen i förhållande till modulen.
OBS! Undvik att klämma de passerande kablarna när den elektriska armaturen sätts in.

RUS После установки лампы вновь вставьте электрическую монтировку «M» таким образом, чтобы она пришлась по центру модуля.
ПРИМЕЧАНИЕ: При повторной установке электрической монтировки избегайте защемления проводов.

CN 安装灯具以后，再重新把电器配件"M"插入灯具的中间。
注意：当重新插入电器配件时，请避免压迫通过的电缆。

art. 7883 - 7884 - 7885
7886 - 7887 - 7888 - 7889



I Nell'eventuale sostituzione di una o più lampade, riposizionare i faston '**F**" come indicato in figura.

GB When replacing one or more lamps, reposition the fastons "**F**" as indicated in the figure.

F En cas de remplacement d'une ou de plusieurs lampes, remontez les faston '**F**" comme illustré.

D Falls eine oder mehrere Lampen ausgetauscht werden müssen, positionieren Sie die Fastons "**F**" wieder so, wie in der Abbildung dargestellt.

NL Bij eventueel vervangen van een of meer lampen moeten de faston '**F**" weer geplaatst worden zoals aangegeven in de afbeelding.

E En caso de sustitución de una o más lamparas, volver a colocar los faston '**F**" según ilustrado en la figura.

DK Ved udskiftning af en eller flere lyskilder, skal man genindsætte faston-terminalerne "F", som vist i figuren.

N Ved bytte av én eller flere lamper, sett på plass festene "F" som indikert på figuren.

S Vid eventuellt byte av en eller flera lampor, placera snabbkopplingen "F" enligt figuren.

RUS При замене одной или нескольких ламп восстановите разъем "F", как показано на схеме.

CN 更换一个或多个光源时，如图所示重新安置紧固件"F"。

I **N.B.:** Reinserendo la montatura elettrica, evitare lo schiacciamento dei cavi.

GB **N.B.:** When re-assembling the electric installation, try to avoid squashing the cables.

F **N.B.:** Lors du remontage de l'installation électrique, veillez à ne pas écraser les câbles.

D **N.B.:** Achten Sie bei Wiedereinsetzen der Elektro-Fassung darauf, die Kabel nicht einzuklemmen.

NL **N.B.:** Als men het electrische montuur weer terugzet, moet men voorkomen dat de hier langs lopende kabels worden platgedrukt.

E **NOTA:** Al volver a introducir la montura eléctrica, evite el aplastamiento de los cables.

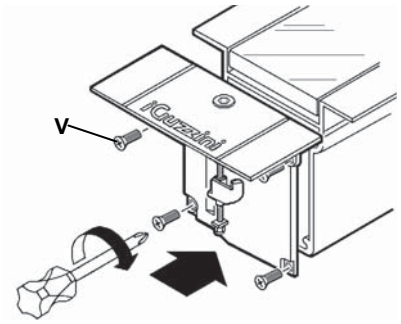
DK **N.B.:** Når det elektriske beslag genmonteres, skal man passe på, at ledningerne ikke klemmes sammen.

N **N.B.:** Prøv å unngå å klemme kablene ved remontering av den elektriske installasjonen.

S **OBS!** Undvik att klämma kablarna när den elektriska armaturen sätts in.

RUS ПРИМЕЧАНИЕ: При повторной установке электрической монтировки избегайте защемления проводов.

CN 注意：当重新插入电器配件时，请避免压迫 电缆。



I Serrare le viti '**V**" passando da una vite a quella diametralmente opposta, accertandosi che siano posizionate al centro delle rispettive sedi sul prodotto.

GB Tighten screws '**V**" going from one screw to the one which is diametrically opposite, making sure that they are located in the centre of their respective housings on the product.

F Serrez les vis "**V**" dans l'ordre suivant: passez d'une vis à celle qui lui est diamétralement opposée et contrôlez qu'elles sont bien centrées dans leurs logements respectifs prévus sur le produit.

D Ziehen Sie die Schrauben '**V**" zu, indem Sie immer erst eine Schraube, dann die ihr gegenüberliegende fest ziehen und sich dabei vergewissern, dass sich die Schrauben genau in der Mitte des auf dem Artikel vorgesehenen Loches befinden.

NL Draai de schroeven '**V**" aan, van een schroef naar de diametrisch tegenovergelegen, en let erop dat ze in het midden van hun respectievelijke behuizingen op het apparaat worden aangebracht.

E Apretar los tornillos '**V**" pasando de un tornillo al tornillo diametralmente opuesto, asegurándose de que los tornillos están colocados en el centro de sus sedes en el producto.

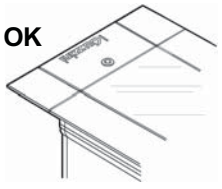
DK Spænd skruerne "V" i en diametral rækkefølge, og sørg for, at de sidder midt i deres sæder på produktet.

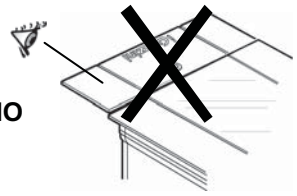
N Trekk til skruene "V" ved å gå fra én skrue til den som er diametrisk motsatt, slik at de plasseres i senter av respektive hus på produktet.

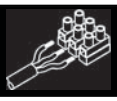
S Dra åt skruvarna "V". Korsdra dem och försäkra dig om att de sitter i mitten i förhållande till respektive säten på utrustningen.

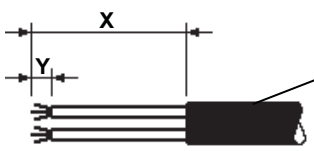
RUS Закрутите шурупы "V" , переходя от одного шурупа к противоположному, проверяя, чтобы шурупы были расположены в центрах своих гнезд в приборе.

CN 依次拧紧螺丝"V"，包括相对的螺丝，确认螺丝安置于产品上各自壳体的中心。





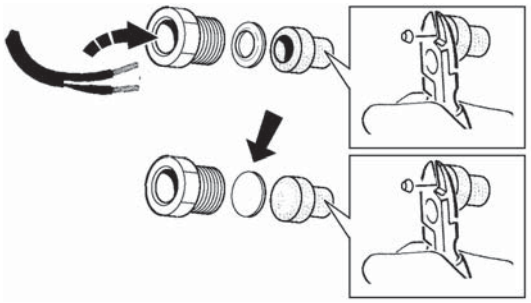


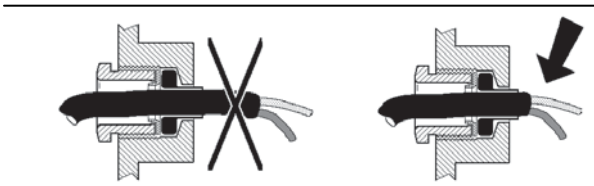


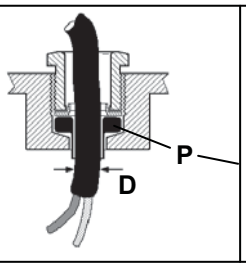
ALIMENTAZIONE
POWER SUPPLY
ALIMENTATION
EINSPEISUNG
STROOMVERZORGING
CEBADOR
STRØMFORSYNING
STRØMFORSYNING
ELFÖRSÖRJNING
ЭЛЕКТРОПИТАНИЕ
电源

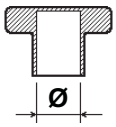
ART.	**X** (mm)	**Y** (mm)
7878 - 7879 - 7880 - 7881 - 7882 **7890 - 7891 - 7892 - 7893**	90	10
7883 - 7884 - 7885 - 7886 **7887 - 7888 - 7889**	70	9

TIPO CAVO - TYPE OF CABLE - TYPE CÂBLE KABELTYP - TYPE KABEL - TIPO CABLE-LEDNINGSTYPE - KABELTYPE -KABELTYP ТИП КАБЕЛЯ-电缆的型号				
ART.	TIPO DI APPLICAZIONE - TYPE OF APPLICATION TYPE D'APPLICATION - ANWENDUNGSART HET SOORT VAN TOEPASSING - TIPO DE APLICACIÓN- ANVENDELSESOMRÅDE-TYPE BRUKSOMRÅDE -TYP AV ANVÄNDNING- ТИП МОНТАЖА - 应用类型			
	INTERNA - INDOOR INTÉRIEURE - INNEN BINNENKANT - INTERNA- INDENDØRS-INNENDØRS -INTERN- ВНУТРЕННИЙ - 室内		ESTERNA - OUTDOOR EXTÉRIEURE - AUßEN BUITENKANT - EXTERNA- UDENDØRS-UTENDØRS -EXTERN- НАРУЖНЫЙ - 室外	
	SIGLA ABBREVIATION SIGLE ABKÜRZUNG CODENUMMER SIGLA SYMBOL FORKORTELSE FÖRKORTNING ОБОЗНАЧЕНИЕ 缩写字母	Sezione Section Section Querschnitt Doorsnede Sección Snit Avsnitt Tvärsnitt Сечение 安装区域 (mm²)	SIGLA ABBREVIATION SIGLE ABKÜRZUNG CODENUMMER SIGLA SYMBOL FORKORTELSE FÖRKORTNING ОБОЗНАЧЕНИЕ 缩写字母	Sezione Section Section Querschnitt Doorsnede Sección Snit Avsnitt Tvärsnitt Сечение 安装区域 (mm²)
7878 - 7879 **7880 - 7881** **7882 - 7883** **7884 - 7885** **7886 - 7887** **7888 - 7889** **7890 - 7891** **7892 - 7893**	H05RN - F	2 x 1	FG7OR	2 x 1,5 2 x 2,5 (Ø max 11,5 mm)
	H07RN - F			
	H07RN - F	2 x 1,5 2 x 2,5 (Ø max 11,5 mm)		
	FG7OR			



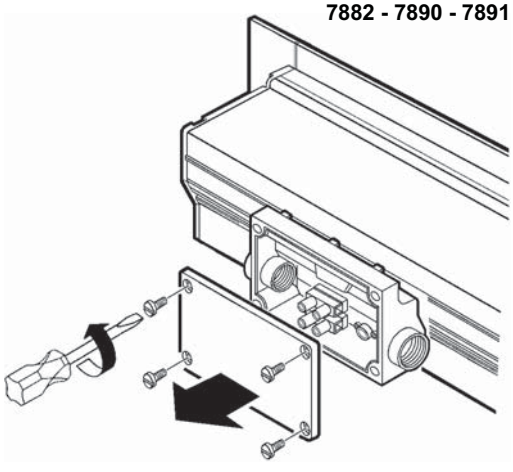


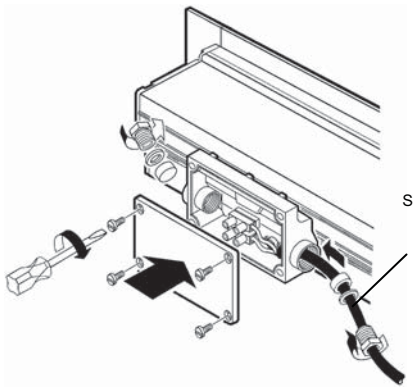




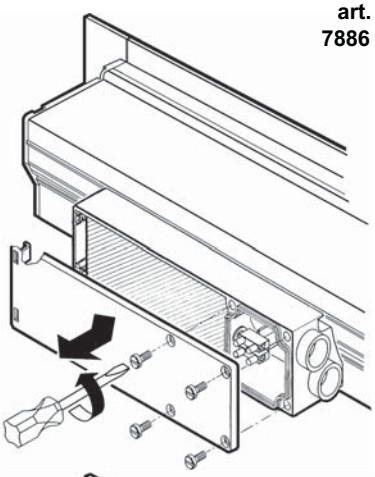
D (mm)	P Ø (mm)
6,5 ÷ 9,0	8,0
9,0 ÷ 11	10,5

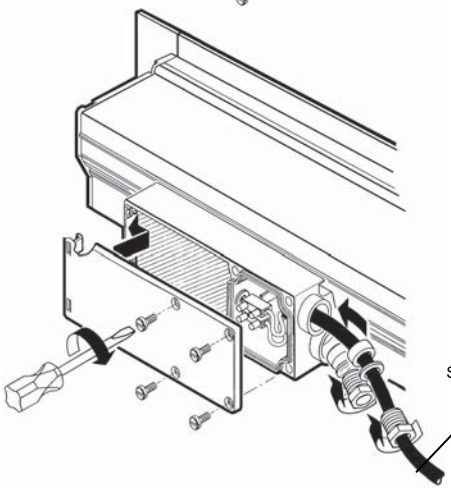
art. 7878 - 7879 - 7880 - 7881
7882 - 7890 - 7891 - 7892 - 7893





art. 7883 - 7884 - 7885
7886 - 7887 - 7888 - 7889





CABLAGGIO PASSANTE
FEEDTHROUGH WIRING
CABLAGE TRAVERSANT
DURCHGANGSKABEL
KABELDOORGANG
CABLEADO PASANTE
GENNEMGÅENDE LEDNINGER
FØRINGSKABLING
KABELGENOMFÖRING
СКВОЗНОЙ МОНТАЖ
连接线架设

I E' possibile collegare in parallelo fino ad un numero massimo di 15 apparecchi (max. 6A per mm² di sezione del cavo).

GB You can connect up to a maximum of 15 luminaires in parallel (max. 6A per mm of cable section).

F Vous pouvez raccorder en parallèle jusqu'à 15 appareils maximum (max. 6A par mm de section du câble).

D Es können bis zu 15 Leuchten parallel angeschlossen werden (max. 6A pro mm Kabelschnittfläche).

NL Het is mogelijk max. 15 apparaten parallel te verbinden (max. 6A per mm doorsnee van de kabel).

E Se pueden conectar en paralelo hasta un máximo de 15 aparatos (máx. 6A para mm de sección del cable).

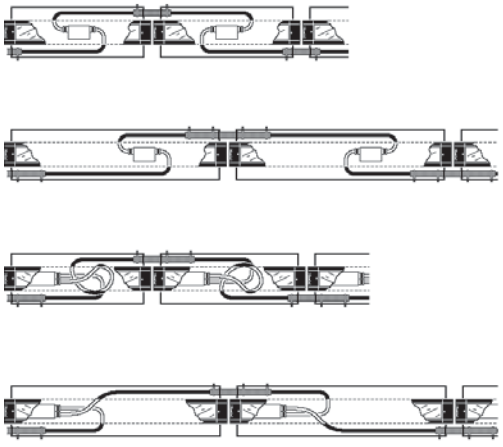
DK Der kan tilsluttes maks. 15 apparater i parallelforbindelse (maks. 6A pr. mm² ledningssnit).

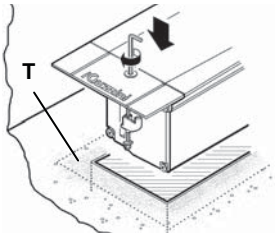
N Du kan tilkople inntil maks. 15 lysarmaturer i parallell (maks. 6 A per mm kabelsnitt).

S Det går att parallellkoppla upp till max. 15 apparater (max. 6A per mm² kabeltvärsnitt).

RUS Можно выполнить параллельное подключение вплоть до 15 приборов (макс. 6 А на мм² се чения кабеля).

CN 用户最多可并联15个灯具(每毫米电线截面max.6A)。





I Accertarsi che l'area "**T**" sulla quale poggierà la cornice non presenti sporgenze.

GB Make sure area "**T**" onto which the frame will rest is free of any projections.

F Contrôlez que la zone "**T**" sur laquelle reposera le cadre ne présente pas d'aspérités.

D Vergewissern Sie sich, dass der Bereich "**T**", also die Stelle, wo der Rahmen aufgelegt wird, keine Unebenheiten aufweist.

NL Let op dat de zone "**T**" waarop de lijst zal rusten geen uitsteeksels vertoont.

E Asegurarse de que el área "**T**", sobre la que se apoyará el marco, no presente salientes.

DK Kontroller, at området "**T**", som kanten støtter mod, ikke rager ud nogen steder.

N Se til at området "**T**" der rammen skal hvile er fri for fremspring.

S Försäkra dig om att det inte finns några utstickande delar på området "**T**" där ramen vilar.

RUS Проверьте, чтобы площадь "**T**", на которую опирается рамка, не имела выступов.

CN 确保框架放置的"**T**"区域无任何照射。

I Per l'eventuale estrazione del modulo, allentare una delle due viti, agire poi sull'altra fino ad ottenere il sollevamento del prodotto.

GB To remove the module – if need be -, loosen one of the two screws then act on the other one until you can lift the product up.

F Pour sortir le module en cas de besoin, desserrez l'une des deux vis puis agissez sur l'autre jusqu'à ce que vous puissiez soulever le produit.

D Zum Herausnehmen des Moduls lockern Sie eine der beiden Schrauben und drehen Sie an der anderen so lange, bis es sich hebt.

NL Voor eventueel verwijderen van het armatuur moet u een van de twee schroeven los schroeven en vervolgens aan de andere draaien totdat u het product kunt opheffen.

E Para la eventual extracción del módulo, aflojar uno de los dos tornillos y después ir aflojando el otro hasta lograr que el producto se levante.

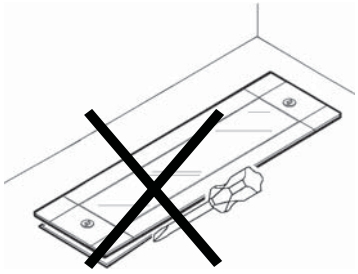
DK For at trække modulet ud skal man løsne en af de to skruer og dreje den anden, så produktet løftes.

N For å fjerne modulen - hvis det er nødvendig - løsnes én av de to skruene og den andre løsnes forsiktig inntil produktet kan løftes opp.

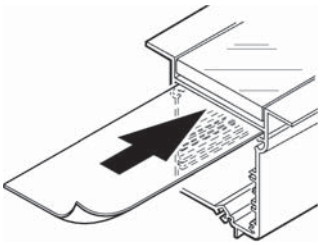
S Om modulen måste dras ut, lossa på en av de två skruvarna och sedan på den andra skruven för att lyfta upp modulen.

RUS При необходимости демонтировать модуль ослабьте один из шурупов, затем ослабьте другой вплоть до высвобождения прибора.

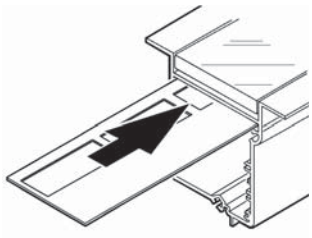
CN 如需拆卸模块，旋开两个螺丝中的一个，然后松动另一个，直到可以提起产品。



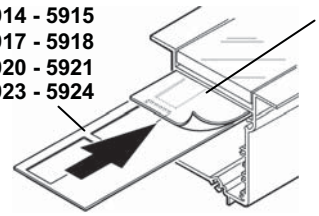
INSTALLAZIONE DEGLI ACCESSORI - INSTALLING THE ACCESSORIES
INSTALLATION DES ACCESSOIRES - INSTALLATION DER ZUBEHÖRTEILE
HET INSTALLEREN VAN DE ACCESSOIRES - INSTALACION DE ACCESORIOS
INSTALLATION AF TILBEHØR - INSTALLERING AV TILBEHØRET - INSTALLATION AV TILLBEHÖR - МОНТАЖ ВСПОМОГАТЕЛЬНЫХ КОМПЛЕКТУЮЩИХ 配件安装



art. 5501 - 5504 - 5505
5506 - 5507 - 5528
5529 - 5530 - 5531
5532 - 5533 - 5534



art. 5913 - 5914 - 5915
5916 - 5917 - 5918
5919 - 5920 - 5921
5922 - 5923 - 5924



art. 5501 - 5504 - 5505
5506 - 5507 - 5528
5529 - 5530 - 5531
5532 - 5533 - 5534

I Installando contemporaneamente il filtro colorato e la griglia frangiluce, inserire prima il filtro colorato, quindi, tenendo l'estremità dello stesso, la griglia frangiluce.

GB When installing the coloured filters at the same time as the baffle grid, insert the coloured filters first and then, holding the end of the latter, insert the baffle grid.

F Si vous installez à la fois le filtre coloré et la grille de défilement, montez d'abord le filtre coloré puis, en tenant ce dernier par son extrémité, montez la grille de défilement.

D Wenn Sie gleichzeitig auch den Farbfilter und den Wabenraster anbringen, so fügen Sie zuerst den Farbfilter ein; daraufhin halten Sie den Rand desselben fest und setzen Sie den Wabenraster ein.

NL Bij het gelijktijdig installeren van de gekleurde filter en het lichtscherm, wordt eerst de gekleurde filter geplaatst en vervolgens het lichtscherm, dat aan het uiteinde wordt vastgehouden.

E Al instalar contemporáneamente el filtro cromático y la rejilla antideslumbrante, introducir el filtro cromático y luego, sujetando la extremidad del filtro mismo, la rejilla antideslumbrante.

DK Hvis man samtidig installerer farvefiltret og lyssprederen, skal man først sætte farvefiltret i. Hold om enden på filtret og sæt derefter lyssprederen i.

N Ved installering av de fargede filtrene samtidig med lysskjermen, sett inn de fargede filtrene først og deretter, samtidig som enden av disse holdes, settes lysskjermen inn.

S Montera det färgade filtret och ljusspridargallret samtidigt. Sätt först in det färgade filtret. Håll sedan i filtrets ände och sätt in ljusspridargallret.

RUS В случае одновременной установки цветного фильтра и диффузора сначала вставляется цветной фильтр, а затем, удерживая его края, вставляется диффузор.

CN 在安装分光网格的同时安装彩色滤光器，首先插入彩色滤光器，然后握住分光网格的尾端，插入折流格。

I In caso di rottura del vetro il prodotto non può essere utilizzato, contattare il costruttore per la sua sostituzione.

GB Should the glass break, the product cannot be used and you should contact the manufacturer for its replacement.

F En cas d'endommage de l'écran de protection le produit ne peut pas être utilizé, contactez le fabricant pour le remplacement.

D Falls das Glas kaputt sein sollte, kann das Produkt nicht verwendet werden. Kontaktieren Sie in dem Fall den Hersteller, um das Glas zu ersetzen.

NL Als het glas gebroken is kan het apparaat niet worden gebruikt en moet u zich tot de fabrikant wenden voor het vervangen van het glas.

E No utilizar el producto en caso de ruptura del vidrio y contactar el fabricante para la sustitución.

DK Hvis produktets glas ødelægges, kan det ikke anvendes. Kontakt forhandleren med henblik på udskiftning.

N Hvis glasset skulle knuses, kan ikke produktet brukes, og du må ta kontakt med produsenten for å få det skiftet.

S Om glaset går sönder kan inte produkten användas. Kontakta tillverkaren för att byta ut glaset.

RUS В случае разбивания стекла не используйте прибор, обратитесь к его производителю для замены.

CN 一旦玻璃破碎后产品将不能再使用，须联系生产商予以更换。

Headquarters iGuzzini illuminazione spa
via Mariano Guzzini, 37 - 62019 Recanati Italy

SECTION 31 2300 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns, and plantings.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Base course for asphalt paving.
6. Excavating and backfilling trenches within building lines.
7. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for granular course over vapor retarder.
2. Division 32 Sections for finish grading, including placing and preparing topsoil for lawns and plantings.

1.3 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Layer placed between the subbase course and asphalt paving.

C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

K. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.
2. Drainage fabric.

B. Material Test Reports: From a qualified testing agency, engaged by the Contractor, indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Contractor shall engage an independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

B. Preexcavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted in writing by Contract Officer and then only after arranging to provide temporary utility services according to requirements indicated:

1. Do not proceed with utility interruptions without Contract Officer's written permission.
2. Contact utility-locator service for area where Project is located before excavating.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Backfill and Fill: Satisfactory soil materials.

E. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2- inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

H. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

I. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch sieve and 0 to 5 percent passing a No. 8 sieve.

J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:

1. Grab Tensile Strength: 110 lbf; ASTM D 4632.
2. Tear Strength: 40 lbf; ASTM D 4533.
3. Puncture Resistance: 50 lbf; ASTM D 4833.
4. Water Flow Rate: 150 gpm per sq. ft.; ASTM D 4491.
5. Apparent Opening Size: No. 50; ASTM D 4751.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: 12 inches on each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.

3.6 APPROVAL OF SUBGRADE

A. Notify Contract Officer when excavations have reached required subgrade.

B. If Contract Officer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Contract Officer.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Contract Officer.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Contract Officer.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

2. Location of any stockpile area must be approved by the Owner or Owner Representative.

3.9 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.10 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Backfill trenches excavated under footings and within 18 inches of bottom of footings; fill with concrete to elevation of bottom of footings.

C. Place and compact initial backfill of subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

D. Coordinate backfilling with utilities testing.

E. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

F. Place and compact final backfill of satisfactory soil material to final subgrade.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

C. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.

3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

3.12 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 92 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 85 percent.

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.15 SUBSURFACE DRAINAGE

A. Drainage Piping: Drainage pipe is specified in Division 2 Section "Foundation Drainage Systems."

B. Subsurface Drain: Place a layer of drainage fabric around perimeter of drainage trench as indicated. Place a 6-inch course of filter material on drainage fabric to support drainage pipe. Encase drainage pipe in a minimum of 12 inches.

1. Compact each course of filter material to 95 percent of maximum dry unit weight according to ASTM D 698.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade. Overlay drainage backfill with one layer of drainage fabric, overlapping sides and ends at least 6 inches.

1. Compact each course of filter material to 95 percent of maximum dry density according to ASTM D 698.
2. Place and compact impervious fill material over drainage backfill to final subgrade.

3.16 SUBBASE AND BASE COURSES

A. Under pavements and walks, place subbase course on prepared subgrade and as follows:

1. Place base course material over subbase.
2. Compact subbase and base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
3. Shape subbase and base to required crown elevations and cross-slope grades.
4. When thickness of compacted subbase or base course is 6 inches or less, place materials in a single layer.
5. When thickness of compacted subbase or base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

B. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.17 DRAINAGE COURSE

A. Under slabs-on-grade, install drainage fabric on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends. Place drainage course on drainage fabric and as follows:

B. Under slabs-on-grade, place drainage course on prepared subgrade and as follows:

1. Compact drainage course to required cross sections and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
2. When compacted thickness of drainage course is 6 inches or less, place materials in a single layer.
3. When compacted thickness of drainage course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Have testing agency inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Contract Officer.

D. Testing agency shall test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Contract Officer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil to designated storage areas on Government's property. Stockpile or spread soil as directed by Contract Officer.

1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Government's property.

END OF SECTION 31 2000

SECTION 32 1216 – HOT MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Pavement-marking paint

B. Related Sections include the following:

1. Division 31 Section "Earthwork" for subgrade preparation, grading and subbase course.
2. Division 32 Section "Cement Concrete Paving" for pavement marking and finishes.

1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.

1. Standard Specification: Maryland State Highway Administration.
2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Qualification Data: For manufacturer.

C. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

C. Regulatory Requirements: Comply with Standard Specifications of Maryland State Highway Administration for asphalt paving work.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet the provisions of the Standard Specifications of the Maryland State Highway Administration.

2.2 AUXILIARY MATERIALS

A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248.

1. Color: Yellow and White or as directed by Owner.

2.3 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Base Course: Hot Mix Asphalt Superpave 25.0 mm, PG 64-22
2. Surface Course: Hot Mix Asphalt Superpave 9.5 mm, PG 64-22

PART 3 - EXECUTION

3.1 GENERAL

A. All work to be preformed in accordance with the Standard Specification of the Maryland State Highway Administration.

B. A traffic control plan should be provided to the Maryland State highway Administration and approvals obtained before the commencement of any work in the State right-of-way.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Contract Officer.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.4 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 32 1216

SECTION 32 1313 – CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior cast-in-place concrete for curb and gutter.
2. Concrete materials.
3. Mixture design.
4. Placement procedures.
5. Base course for asphalt paving.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for granular course over vapor retarder.
2. Division 31 Section "Earthwork" for subgrade preparation, grading and subbase course.
3. Division 32 Sections for finish grading, including placing and preparing topsoil for lawns and plantings.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Samples: 10-lb sample of exposed aggregate.

D. Qualification Data for manufacturer.

E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates

F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

G. Field quality-control test reports.

H. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
3. Obtain Architect's approval of mockups before starting construction.
4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
5. Demolish and remove approved mockups from the site when directed by Architect.
6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete producer.
d. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by Contract Officer and then only after arranging to provide temporary utility services according to requirements indicated:

1. Do not proceed with utility interruptions without Contract Officer's written permission.
2. Contact utility-locator service for area where Project is located before commencing work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

C. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

H. Plain Steel Wire: ASTM A 82, as drawn.

I. Deformed-Steel Wire: ASTM A 496.

J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain.

K. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

P. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I, Type II, Type I/II, or Type III. Supplement with the following:

a. Fly Ash: ASTM C 618, Class C or F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag cement.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: 3/4 to 1 inch nominal.

D. Water: ASTM C 94/C 94M.

E. Air-Entraining Admixture: ASTM C 260.

F. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

1. Products:

a. Monofilament Fibers:

1) Axim Concrete Technologies; Fibrasol IIP.
2) Euclid Chemical Company (The); Fiberstrand 100.
3) FORTA Corporation; Forta Mono.
4) Grace, W. R. & Co.--Conn.; Grace MicroFiber.
5) Metalcrete Industries; Polystrand 1000.
6) SI Concrete Systems; Fibermix Stealth.

b. Fibrillated Fibers:

1) Axim Concrete Technologies; Fibrasol F.
2) FORTA Corporation; Forta.
3) Euclid Chemical Company (The); Fiberstrand F.
4) Grace, W. R. & Co.--Conn.; Grace Fibers.
5) SI Concrete Systems; Fibermesh.

2.6 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

1. Products:

a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edeco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.
g. Kaufman Products, Inc.; Vapor Aid.
h. Lambert Corporation; Lambco Skin.
i. L&M Construction Chemicals, Inc.; E-Con.
j. MBT Protection and Repair, ChemRex Inc.; Confilm.
k. Meadows, W. R., Inc.; Sealtight Evapre.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
n. Sika Corporation, Inc.; SikaFilm.
o. Symons Corporation; Finishing Aid.
p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

1. Products:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. Burke by Edoko; Aqua Resin Cure.
c. ChemMasters; Safe-Cure Clear.
d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
f. Euclid Chemical Company (The); Kurez DR VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; Aqua Kure-Clear.
i. L&M Construction Chemicals, Inc.; L&M Cure R.
j. Meadows, W. R., Inc.; 1100 Clear.
k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
l. Symons Corporation; Resi-Chem Clear.
m. Tamms Industries Inc.; Horncure WB 30.

n. Unitex; Hydro Cure 309.
o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

F. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

1. Products:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 WP WB.
b. Burke by Edoco; Resin Emulsion White.
c. ChemMasters; Safe-Cure 2000.
d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
e. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).
f. Euclid Chemical Company (The); Kurez VOX White Pigmented.
g. Kaufman Products, Inc.; Thinfilm 450.
h. Lambert Corporation; Aqua Kure-White.
i. L&M Construction Chemicals, Inc.; L&M Cure R-2.
j. Meadows, W. R., Inc.; 1200-White.
k. Symons Corporation; Resi-Chem White.
l. Tamms Industries, Inc.; Horncure 200-W.
m. Unitex; Hydro White.
n. Vexcon Chemicals, Inc.; Certi-Vex Enviocure White 100.

2.7 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.

1. Manufacturers:

a. Bayer Corporation.
b. ChemMasters.
c. Conspec Marketing & Manufacturing Co., Inc.
d. Davis Colors.
e. Elementis Pigments, Inc.
f. Hoover Color Corporation.
g. Lambert Corporation.
h. Scofield, L. M.Company.
i. Solomon Colors.

C. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

D. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

E. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

F. Chemical Surface Retarder: Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch .

1. Products:

a. Burke by Edeco; True Etch Surface Retarder.
b. ChemMasters; Exposee.
c. Conspec Marketing & Manufacturing Co., Inc.; Delay S.
d. Euclid Chemical Company (The); Surface Retarder S.
e. Kaufman Products, Inc.; Expose.
f. Metalcrete Industries; Surftard.
g. Nox-Crete Products Group, Kinsman Corporation; Crete-Nox TA.
h. Scofield, L. M. Company; Lithotex.
i. Sika Corporation, Inc.; Rugasol-S.
j. Vexcon Chemicals, Inc.; Certi-Vex Envioset.

G. Pigmented Mineral Dry-Shake Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Products:

a. Conspec Marketing & Manufacturing Co., Inc.; Conshake 600 Colortone.
b. Dayton Superior Corporation; Quartz Tuff.
c. Euclid Chemical Company (The); Surflex.
d. Lambert Corporation; Colorhard.
e. L&M Construction Chemicals, Inc.; Quartz Plate FF.
f. MBT Protection and Repair, ChemRex Inc.; Mastercron.
g. Metalcrete Industries; Floor Quartz.
h. Scofield, L. M. Company; Lithochrome Color Hardener.
i. Symons Corporation; Hard Top.

H. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

2.8 PAVEMENT MARKINGS

A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with FS TT-P-115, Type I or II or AASHTO M 248, Type N or F.

1. Color: White and Yellow or as directed by Owner.

B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 45 minutes.

1. Color: White and Yellow or as directed by Owner.

C. Glass Beads: AASHTO M 247, Type 1.

2.9 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4500 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 4 inches, plus or minus 1 inch (25 mm).

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
2. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
3. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals, as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

G. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

H. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete mixes of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete mixes larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 2 Section "Earthwork."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
2. Provide tie bars at sides of pavement strips where indicated.
3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

M. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

O. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F , uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in pavement surfaces as follows:

1. Immediately after float finishing, spray-apply chemical surface retarder to pavement according to manufacturer's written instructions.
2. Cover pavement surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
3. Without dislodging aggregate, remove excess mortar by lightly brushing surface with a stiff, nylon-bristle broom.
4. Fine-spray surface with water and brush. Repeat water flushing and brushing cycle until cement film is removed from aggregate surfaces to depth required.

B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on pavement surface. Tamp aggregate into plastic concrete, and float finish to entirely embed aggregate with mortar cover of 1/16 inch .

1. Spray-apply chemical surface retarder to pavement according to manufacturer's written instructions.
2. Cover pavement surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
3. Without dislodging aggregate, remove excess mortar by lightly brushing surface with a stiff, nylon-bristle broom.
4. Fine-spray surface with water and brush. Repeat water flushing and brushing cycle until cement film is removed from aggregate surfaces to depth required.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on pavement surface according to manufacturer's written instructions and as follows:

1. Uniformly spread 25 lb/100 sq. ft. dampened slip-resistive aggregate over pavement surface in 2 applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over pavement surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
4. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

D. Rock-Salt Finish: After initial floating, uniformly spread 5 lb/100 sq. ft. rock salt over pavement surface.

1. Cover pavement surface with 1-mil- thick polyethylene sheet and remove sheet when concrete has hardened and 7-day curing period has elapsed.
2. Embed rock salt into plastic concrete, power float concrete, and trowel finish.
3. After 7-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt.

E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to pavement surface according to manufacturer's written instructions and as follows:

1. Uniformly spread dry-shake hardener at a rate of 100 lb/100 sq. ft., unless greater amount is recommended by manufacturer to match pavement color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over pavement surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second dry-shake hardener application, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed by power floating.
3. After final floating, apply a hand-trowel finish followed by a broom finish to concrete.
4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.10 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch .
2. Thickness: Plus 3/8 inch , minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch .
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch .
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch .
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches .
8. Joint Spacing: 3 inches .
9. Contraction Joint Depth: Plus 1/4 inch , no minus.
10. Joint Width: Plus 1/8 inch , no minus.

3.11 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Spread glass beads uniformly into wet pavement markings at a rate of 6 lb/gal..

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.13 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313

SECTION 32 1400 - UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete pavers set in bituminous setting beds.

B. Related Sections:

1. Division 32 Section "Concrete Paving" for concrete base under unit pavers and or cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers.

1.3 ACTION SUBMITTALS

A. Product Data: For materials other than water and aggregates.

B. Product Data: For the following:

1. Concrete pavers.
2. Detectable Warning paver (for handicap crossing ramps).
3. Bituminous setting materials.

C. Samples for Initial Selection: For the following:

1. Each type of unit paver indicated.

D. Samples for Verification:

1. Full-size units of each type of unit paver indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store asphalt cement and other bituminous materials in tightly closed containers.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

A. Regional Materials: Provide concrete pavers that have been manufactured within 500 miles (800 km) of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

B. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.

1. Manufacturers:

a. Basis of design manufacturer: Hanover Architectural Products, Hanover, PA. www.hanoverpavers.com.

2. Thickness: 3 inches (vehicular grade).
3. Face Size and Shape: 4” x 8”
4. Type: Hanover prest brick.
5. Color: Color A: Charcoal, Color B: Limestone Gray.
6. Finish: Traditional Natural Finish.

C. Detectable Warning Pavers: Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.

1. Manufacturers:

a. Basis of design manufacturer: Hanover Architectural Products, Hanover, PA. www.hanoverpavers.com.

2. Thickness: 2”
3. Face Size and Shape: 11 ¾” x 11 ¾”
4. Color: Charcoal.
5. Finish: Natural Finish.
6. Type: Detectable warning paver with truncated domes.

2.2 BITUMINOUS SETTING-BED MATERIALS

A. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.

C. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.

D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.

1. Provide sand of color needed to produce required joint color.

2.3 BITUMINOUS SETTING-BED MIX

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to 300 deg F (149 deg C).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 PREPARATION

A. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: As shown on drawings.

F. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
1. Install job-built concrete edge restraints to comply with requirements in Division 03 Section "Cast-in-Place Concrete."

3.4 BITUMINOUS SETTING-BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating 3/4-inch- (19-mm-) deep control bars approximately 11 feet (3.3 m) apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F (121 deg C). Strike setting bed smooth, firm, even, and not less than 3/4 inch (19 mm) thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of 3/4 inch (19 mm). Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F (85 deg C).

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch (1.6 mm). Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.5 REPAIRING AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 32 1400

SECTION 32 9100 – PLANTING SOIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section Includes:

B. Related Sections include the following:

1. Division 31 Section "Earthwork" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:

1. Manufacturer's certified analysis for standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Material Test Reports: For existing surface soil and imported topsoil.

1.5 QUALITY ASSURANCE

A. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

1. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.

1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.

2. Topsoil Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.
3. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:

1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum 75 percent passing through No. 60 (0.25-mm) sieve.

2. Class: Class O, with a minimum 95 percent passing through No. 8 (2.36-mm) sieve and a minimum 55 percent passing through No. 60 (0.25-mm) sieve.
3. Provide lime in form of dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 (3.35-mm) sieve and a maximum 10 percent passing through No. 40 (0.425-mm) sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

G. Sand: Clean, washed, natural or manufactured, free of toxic materials.

H. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with at least 0.15 lb (2.4 kg) of ammonium nitrate or 0.25 lb (4 kg) of ammonium sulfate per cubic foot (cubic meter) of loose sawdust or ground bark.

E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

F. Transplant Innoculant (for all non-ericaceous trees and shrubs):

1. Mycorrhizal fungi transplant innoculant.

a. Rate of Application: In accordance with manufacturer's recommendations for shrubs and planting beds.

2.4 FERTILIZER

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

PART 3 - EXECUTION

3.1 PLANTING SOIL MIXES

A. Turfgrass Lawn Planting Soil Mix: Mix topsoil with the following soil amendments in the following quantities:

1. Ratio of Loose Compost to Topsoil by Volume: 1:3.
2. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m) or per soil test results recommendations
3. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): Per soil test recommendations

B. Planting Soil Mix Type 1: For individual plant pits, planting beds:

1. Quantities per cubic yard:

a. 3/4 cubic yard existing soil from plant pits or on-site stockpiles.
b. ¼ cubic yard organic matter. Use organic matter compatible with plant materials specified. Include sand as needed.

2. Transplant innoculant plus chemical additives and/or soil amendments as specified and recommended by soil tests and as approved by the Landscape Architect.

3.2 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6. Remove stones larger than 1 in any dimension and sticks, roots, rubbish, and other.

1. Apply fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
b. Mix lime with dry soil before mixing fertilizer.

3. Spread planting soil mix to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix.
b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.

a. Apply fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.

4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.3 PLANTING BED ESTABLISHMENT

A. Loosen subgrade of planting beds to a minimum depth of 8 inches (200 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous.

1. Apply fertilizer directly to subgrade before loosening in accordance with “Planting Soil Mix” Article in Part 2, and in accordance with soil laboratory test recommendations per Division 2 Section “Planting Soil”.
2. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    b. Mix lime with dry soil before mixing fertilizer.

3. Spread planting soil mix to a depth of as indicated on the drawings but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil mix.

B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.4 TREE AND SHRUB EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward, so that top of pit is larger then bottom of pit. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for planting stock.
2. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. If drain tile is shown or required under planted areas, excavate to top of porous backfill over tile.

B. Subsoil removed from excavations may be used as backfill.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

END OF SECTION 32 9100

SECTION 32 9200 - LAWNS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Sodding.
2. Lawn renovation.

B. Related Sections include the following:

1. Division 32 Section "Earthwork" for excavation, filling and backfilling, and rough grading.
2. Division 32 Section "Planting Soil" for soil preparation of areas to receive lawns and grasses.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod and identifying source, including name and telephone number of supplier.

C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.

D. Qualification Data: For landscape Installer.

E. Material Test Reports:

1. Existing surface soil.
2. Imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

1.6 SCHEDULING

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: March 15-June15
2. Fall Planting: September 15 – November 15

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.7 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: 60 days from date of Substantial Completion.

a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

2. Sodded Lawns: 30 days from date of Substantial Completion.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water lawn at a minimum rate of 1 inch (25 mm) per week.

D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass 2 to 3 inches (50 to 75 mm) high.

E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to lawn area.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

A. Turfgrass Sod: Certified complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of

uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Sun and Partial Shade: Proportioned by weight as follows:

a. 20 percent Kentucky bluegrass (Poa pratensis).
b. 60 percent tall fescue (Festuca rubra), minimum of three (3) varieties listed below:

1) 2nd Millennium
2) Avenger
3) Biltmore
4) Bingo
5) Blackwatch
6) Bravo
7) Cochise II(3)
8) Cochise
9) III
10) Constitution
11) Coyote II
12) Crossfire II(3,4)
13) Davinci(3)
14) Daytona(3)
15) Endeavor(3),
16) Falcon IV
17) Fidelity
18) Forte
19) Good-En(3,4)
20) Grande(4)
21) Grande II
22) Greenkeeper WAF,
23) Guardian 21
24) Houndog 5
25) Hunter
26) Inferno
27) Justice
28) Magellan
29) Masterpiece
30) Matador
31) (3)
32) Matador GT(3)
33) Onyx(3,4)
34) Padre
35) Picasso(3)
36) Penn 1901
37) Raptor
38) Rebel Exeda,
39) Regiment II
40) Rembrandt(3)
41) Southern Choice II(3)
42) SR 8250(3)
43) Taos
44) Tarheel
45) Tarheel
46) II
47) Tempest
48) Titanium
49) Tombstone
50) Turbo
51) Ultimate(3)
52) Watchdog
53) and Wolfpack.

c. 10 percent perennial ryegrass (Lolium perenne).
d. 10 percent redtop (Agrostis alba).

2.2 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding overspray.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 SOIL PREPARATION

A. Division 32 Section “Planting Soil”.

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.

C. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

3.5 LAWN RENOVATION

A. Renovate existing lawn.

B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.

C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.

D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

E. Mow, dethatch, core aerate, and rake existing lawn.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).

I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches (100 mm) of existing soil. Provide new planting soil to fill low spots and meet finish grades.

J. Apply sod as required for new lawns.

K. Water newly planted areas and keep moist until new lawn is established.

3.6 SATISFACTORY LAWNS

A. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.7 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

END OF SECTION 32 9200

SECTION 32 9300 - EXTERIOR PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Trees.
2. Shrubs.
3. Ground covers.
4. Plants, including perennials.
5. Planting Accessories.
6. Mulch.
7. Maintenance and Warranty of Exterior Plants.

B. Related Sections include the following:

1. Division 01 Section “Temporary Tree and Plant Protection”.
2. Division 31 Section "Earthwork" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
3. Division 32 Section “Lawns and Grasses” for turfgrass plantings.

1.2 DEFINITIONS

A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than [diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

B. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.

C. Bare-Root Stock: Exterior plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for kind and size of exterior plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.

E. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching

sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each of the following:

1. 5 lb (2.2 kg) of mineral mulch for each color and texture of stone required, in labeled plastic bags.
2. Edging materials and accessories, of manufacturer's standard size, to verify color selected.

C. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:

1. Manufacturer's certified analysis for standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

D. Qualification Data: For landscape Installer.

E. Planting Schedule: Indicating anticipated planting dates for exterior plants.

F. Photographs: Submit photographs of plants, as requested by the Landscape Architect, prior to Observation, as listed under Quality Assurance, below. Photographs shall include a person holding a clearly-marked measuring rod next to plants. Photographs shall exhibit the size, growth habit, and general visual quality of plants. Photographs of dense clusters of plants, in which one plant is not distinguishable from another, are not acceptable. Digital photographs submitted via email are acceptable.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time, English-speaking, supervisor on Project site when exterior planting and regular maintenance is in progress.
2. Substitutions of plants will not be permitted unless authorized in writing by the Landscape Architect, prior to purchase for this Project.

3. Selection of exterior plants purchased under allowances will be made by Landscape Architect, who will tag plants at their place of growth before they are prepared for transplanting.

B. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches (150 mm) above ground for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

C. Observation: Landscape Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store, irrigate, maintain, and otherwise protect balled and burlapped trees in a manner that prevents mechanical injury and physiological stress between the time of digging and delivery.

B. Deliver exterior plants freshly dug.

1. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

C. Do not prune trees and shrubs before delivery, except as approved by Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Irrigate balled and burlapped plants thoroughly immediately prior to transport. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.

D. Handle planting stock by root ball. Planting stock with cracked or broken root balls will not be accepted.

E. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants trees in shade, protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots in water for two hours if dried out.
2. Set balled stock on ground and cover ball with woodchip mulch or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.6 COORDINATION

A. Contractor is responsible for determining plant quantities per planting plan. Contractor is responsible for filling all areas on plans shown to be planted on planting plan. Contractor shall prepare his or her own quantity list from the plan(s). All ground cover, perennial, and annual beds are to be filled at the specified spacing.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: March 15 to June 15
   a. Quercus species
   b. Deciduous material
   c. Herbaceous material
2. Fall Planting: September 15 to November 15
   a. Evergreen material
   b. Deciduous material other than Quercus spp.
   c. Herbaceous material
3. No Planting shall occur between June 15 and September 14, inclusive, except annuals, or as authorized by the Landscape Architect.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

D. Coordination with Other Work: Coordinate planting with all other work of the project, including the following:
1. Landscape Irrigation: Coordinate planting with location of irrigation equipment. Coordinate aiming of landscape irrigation equipment to ensure that plantings do not impair the irrigation system from functioning as designed. Ensure that plant locations do not block irrigation spray and do not interfere with other irrigation equipment, including moisture sensors and rain sensors.
2. Site Lighting and Electrical Equipment: Coordinate planting with site lighting to ensure that plantings do not impair site lighting from illuminating the site as designed. Following planting installation, coordinate aiming of site lighting that is intended to illuminate plants.
3. Tree Soil Panels with Brick Pavers over Steel Grating: Coordinate planting with brick paving over steel grating. Soil panels shall be excavated following construction of curbing and sidewalks. Soil panels and soil panel subdrainage shall not become contaminated, compacted or otherwise disturbed during steel grating or brick paving operations.

4. Root Path work shall be performed following completion of sidewalk hard surface demolition, and utility trenching or any other subsurface construction. Root Path work shall be performed prior to sidewalk base course, sidewalk pavement and root guide installation.
5. Coordinate Root Guide work with tree soil panel excavation, sidewalk work and root path work. Root Guide work shall be performed following completion of root path work, sidewalk work and tree soil panel excavation. Root Guide work shall be performed prior to completely filling tree soil panels with topsoil.

E. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns, unless otherwise acceptable to Landscape Architect.

1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.7 WARRANTY

A. Special Warranty: Warrant all exterior plants covered by this Section, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.

1. Warranty Period for Exterior Plants:
   a. From date of Installation to Substantial Completion.
   b. **One year** from date of Substantial Completion.
2. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
3. Replace without cost to Owner, as soon as weather and soil conditions permit, exterior plants that are more than 25 percent dead or in an unhealthy condition as determined by the Landscape Architect at end of warranty period.

1.8 MAINTENANCE

A. Maintenance Period for all exterior plants covered by this Section: Concurrent with Warranty Period and same duration as Warranty Period. Maintenance requirements are itemized in Part 3 of this Section.

B. Owner will assume maintenance following completion of Maintenance Period.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs in accordance with good horticultural practices under climatic conditions similar to those of the Project for at least two years, unless specifically noted otherwise. Trees and shrubs shall comply with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Trees and shrubs shall exceed AAN standards for quality by being exceptionally heavy, uniform, so trained or favored in development and appearance as

to be superior in form, density and spread of branches, compactness, and symmetry. Determination of quality shall be made by the Landscape Architect. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, leaf spotting, injuries, abrasions, and disfigurement.

B. Trees shall be planted such that the root flare is 1" above adjacent grade, unless the drawings indicate otherwise. Tree planting height shall be dictated by the actual root flare rather than the top of rootball as received from growers or nurseries.

1. Tops of tree rootballs shall be no higher than 2" above the tops of main order tree roots.
2. If main order roots are buried greater than 2" but less than 4" below the top of tree rootballs, contractor must trim rootballs by carefully removing soil from the top of the rootballs so that main order roots are within 2" of the top of rootball.
3. If main order roots are buried greater than 4" below the top of rootball, the tree will be rejected and the contractor must remove the tree from the jobsite.
4. The contractor is responsible for ensuring that trees received on site and planted on site meet the aforementioned specifications regarding tree root flare and rootball. The contractor is responsible for ensuring that the landscape architect has an opportunity to review the tree root flares of trees in the growers field or nursery yard. **If tree root flares are obscured (due to trunk wrap or burlap or other obstructions), landscape architect's acceptance of trees in the grower's yard or nursery shall constitute acceptance of trees WITH THE EXCEPTION of trees whose root flare is buried greater than 4" below top of rootball. In the event that contractor does not allow Landscape Architect to visually observe tree root flares during tree selection at grower's yard or nursery, Landscape Architect reserves the right to reject any tree delivered to the site if tree's root flare is buried greater than 4" below top of rootball, even if Landscape Architect previously accepted said trees at the grower's yard or nursery.**

C. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.

D. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

E. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

F. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height, branching height, and spread, and number label to assure symmetry in planting.

2.2 SHADE AND FLOWERING TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

1. Provide balled and burlapped, balled and potted, or container-grown trees.
2. Branching Height: One-third to one-half of tree height. For street trees branching height shall be one half of tree height.

B. Small Upright or Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:

1. Stem Form**:** Single stem.
2. Provide balled and burlapped trees.

C. Multistem Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:

1. Stem Form: Clump.
2. Provide balled and burlapped trees.

2.3 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

1. Provide balled and burlapped or container-grown shrubs.

2.4 CONIFEROUS EVERGREENS

A. Form and Size: Specimen-quality, exceptionally heavy, densely branched, symmetrically shaped coniferous evergreens and the following grade:

1. Heavy Grade: "XXX."
2. Provide balled and burlapped trees.

2.5 BROADLEAF EVERGREENS

A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

1. Provide balled and burlapped trees.

2.6 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.7 PLANTS

A. Annuals: Provide healthy, disease-free plants of species and variety shown or listed. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed.

2.8 PLANTING SOIL

A. Division 2 Section “Planting Soil Preparation”.

2.9 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood, Ground or shredded bark, or Wood and bark chips.

2.10 STAKES AND GUYS

A. Install Stakes and Guys per methods and locations as shown on the Drawings.

B. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, redwood, or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 2 by 2 inches (50 by 50 mm) by length indicated, pointed at one end.

C. Guy Ties and Guards:
1. Guy and Tie Wire: ASTM A 641/A 641M, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 inch (2.7 mm) in diameter.
2. Guy Cable: For large trees: 5-strand, 3/16-inch- (4.8-mm-) diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches (75 mm) long, with two 3/8-inch (10-mm) galvanized eyebolts.
3. Hose Chafing Guard: Reinforced rubber or plastic hose at least 1/2 inch (13 mm) in diameter, black, cut to lengths required to protect tree trunks from damage.
4. Woven Fabric Guy Ties: Flat, woven, non-fraying, polypropylene material, ¾” wide, white. Arbor Tie or approved equivalent.

D. Guy and Anchoring System: ArborGuy 40E (www.stakingsystems.com), or approved equivalent. ArborGuy guylines, arrowhead anchors, tool-free tensioners.

E. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.

2.11 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs, designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in original, sealed, and fully labeled containers and mix according to manufacturers.

1. Dowax by Dow Chemical Co., or Wilt-Proof by Nursery Specialty Products, Inc.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch- (100-mm-) wide minimum, with stretch factor of 33 percent. Use only where requested by the Landscape Architect.

C. Tree Watering Bags: UV-treated polyethylene irrigation bag reinforced with nylon webbing. All sides to be watertight with ¼" thick heat seals. Bags shall have nylon zippers to allow to be secured to tree or secured to other bags for multiple-bag configuration.

1. Manufacturer: TreeGator, 1-866-873-3428, or approved equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Notify Landscape Architect, in writing, of any conditions that might prevent satisfactory completion. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Test drainage of pits and planting beds. Notify Landscape Architect of potential poor drainage of tree and shrub pits and planting beds. Recommend a program for correction of poor drainage conditions and submit proposal to Landscape Architect. Do not proceed with planting operations in areas of poor drainage until conditions are corrected, or direction is given by the Landscape Architect.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple exterior plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before planting. Make minor adjustments as required.

D. Lay out exterior plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

3.3 PLANTING BED ESTABLISHMENT

A. Division 32 Section “Planting Soil Preparation”.

3.4 TREE AND SHRUB EXCAVATION

A. Division 32 Section “Planting Soil Preparation”.

3.5 TREE AND SHRUB PLANTING

A. Set balled and burlapped stock plumb and in center of pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Cut burlap and wire baskets from top half of root balls, but do not remove from under root balls. Discard removed burlap and wire baskets; do not turn down baskets and leave in tree or shrub pits. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, install transplant inoculants per manufacturer’s directions and water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
3. Prepare surface of planting bed as shown on drawings.

B. Set balled and potted or container-grown stock plumb and in center of pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Carefully remove root ball from container without damaging root ball or plant.
2. Make four (4) evenly spaced vertical cuts in the sides of the root ball with a clean, sharp utility knife. Cuts are to be one inch (1”) deep and are to extend the full height of the rootball.
3. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, install transplant inoculants per manufacturer’s directions and water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
4. Prepare surface of planting bed as shown on drawings.

C. Set fabric bag-grown stock plumb and in center of pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, install transplant inoculants per manufacturer's directions and water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
3. Prepare surface of planting bed as shown on drawings.

D. For bare-root stock, slightly mound soil in bottom of planting pit. Set stock in center of pit or trench with widest part of root collar or trunk flare flush with adjacent finish grade. Spread roots over and around soil mound without tangling or turning toward surface, and carefully work backfill around roots by hand, placing backfill in 6" (150 mm) lifts. When pit is approximately one-half backfilled, install transplant inoculants per manufacturer's directions, then continue to backfill pit. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots. Tamp final layer of backfill. Remove injured roots by cutting cleanly; do not break.

1. Prepare surface of planting bed as shown on drawings.

E. Organic Mulching: Apply 2-inch (50-mm) average thickness of organic mulch extending 12 inches (300 mm) beyond edge of planting pit or trench. Do not place mulch within 3 inches (75 mm) of trunks or stems.

F. Wrap trees of 2-inch (50-mm) caliper and larger with trunk-wrap tape if requested by Landscape Architect. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping.

3.6 TREE AND SHRUB PRUNING

A. Prune, thin, and shape trees and shrubs as directed by Landscape Architect.

B. Prune, thin, and shape trees and shrubs according to standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune shrubs to retain natural character. Shrub sizes indicated are sizes after pruning.

3.7 GUYING AND STAKING

A. Guy and Stake trees as indicated on the drawings. Installation of tree support systems shall be completed within 48 hours of planting, utilizing applicable methods as indicated.

3.8 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants as indicated.

B. Dig holes large enough to allow spreading of roots, and backfill with planting soil.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.9 PLANTING BED MULCHING

A. Mulch backfilled surfaces of planting beds and other areas indicated.

1. Organic Mulch: Apply 2-inch (50-mm) average thickness of organic mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems.

3.10 TREE WATERING BAGS

A. Install a minimum of one tree watering bag per tree. Install multiple bags for trees as recommended by the tree watering bag manufacturer. Fill water bags for each tree.

3.11 INITIAL ACCEPTANCE

A. When all work except maintenance and guarantee program of this contract has been completed, Landscape Architect will perform a Substantial Completion inspection. Provide notification at least ten (10) working days before inspection date.
1. If required a “punch list” of items to be completed by an agreed upon date will be issued by the Landscape Architect after the Substantial Completion inspection.

B. Work will be considered Substantially Complete after all “punch list” items are complete. Notify the Landscape Architect at least five (5) working days before re-inspection date, to verify completion of the “punch list” items.

C. Substantial Completion certificate will be issued and dated by the Landscape Architect following the “punch list” verification inspection.

3.12 MAINTENANCE

A. Maintain all exterior plants covered by this Section, as required to establish healthy, viable plantings, including the following maintenance requirements during the maintenance period indicated in Part 1 of this Section:

1. Mowing;
2. Edging;
3. Pruning; (see attached pruning guidelines for evergreen trees)
4. Cultivating;
5. Watering, including filling tree water bags, do not allow plants to wilt at any time;
6. Weeding;
7. Fertilizing;
8. Mulching;
9. Restoring plant saucers for trees;
10. Maintaining trees support systems at correct tension;
11. Resetting plants to proper grade and vertical position;
12. Insect and Pest Control as required to keep plants free of insects and disease;
13. Restoring or replacing damaged tree wrappings;
14. Removal of trash and debris; and
15. Replacing dead or dying plants.

3.13 FINAL ACCEPTANCE

A. Inspection to determine Final Acceptance of planted areas will be made by the Landscape Architect upon Contractor's request at completion of the two-year Warranty Period. Provide notification at least fifteen (15) working days before requested inspection date.

1. Planted areas will be acceptable provided all requirements, including plant replacements and maintenance, have been complied with and healthy, thriving, and growing plants are established.
2. Remove all Tree Staking and Guying materials prior to Final Acceptance inspection.
3. Knock down, regrade, and remulch all tree pit saucers prior to Final Acceptance inspection.

3.14 CLEANUP AND PROTECTION

A. During exterior planting, keep adjacent pavings and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

3.15 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of off Owner's property.

END OF SECTION 32 9300

RFP No. 612-005, Part B

Request for Proposal

Bioscience Education Center
Phase 2 – Building, Gateway Signage and Road Construction

Germantown Campus

VOLUME 5

Observation Drive East-West Road and Traffic Circle Specifications

Montgomery College
Maryland

Date: March 26, 2012
Montgomery College
Office of Central Facilities
40 W. Gude Drive – Suite 200
Rockville, MD 20850

Bioscience Education Center
Phase 2 – Building, Gateway Signage and Road Construction
Germantown Campus

TABLE OF CONTENTS

VOLUME I

INTRODUCTORY INFORMATION

PROPOSAL REQUIREMENTS

CONTRACT REQUIREMENTS

VOLUME 2 – BUILDING CONSTRUCTION

TECHNICAL SPECIFICATION SECTIONS

DIV. 08 DOORS AND WINDOWS

DIV. 09 FINISHES

DIV. 10 SPECIALTIES

VOLUME 3 – BUILDING CONSTRUCTION

DIV. 20 RESERVED

200000 Common Mechanical / Electrical Requirements

DIV. 21 FIRE SUPPRESSION

210500 Common Work Results for Fire Suppression
211000 Fire Suppression Commissioning
211200 Fire Suppression Standpipes
211313 Wet-Pipe Sprinkler Systems

DIV. 22 PLUMBING

220500 Common Work Results For Plumbing
220516 Expansion Fittings And Loops For Plumbing Piping
220519 Meters And Gages For Plumbing Piping
220523 General-Duty Valves For Plumbing Piping
220529 Hangers And Supports For Plumbing Piping And Equipment
220553 Identification For Plumbing Piping And Equipment
220700 Plumbing Insulation
220800 Plumbing System Commissioning
221113 Facility Water Distribution Piping
221116 Domestic Water Piping
221119 Domestic Water Piping Specialties
221120 Domestic Water Packaged Booster Pumps
221123 Facility Natural-Gas Piping
221316 Storm Drainage And Sanitary Waste And Vent Piping
221123 Facility Natural-Gas Piping
221316 Storm Drainage and Sanitary Waste and Vent Piping
221319 Sanitary Waste And Storm Piping Specialties
221429 Sump Pump
221513 Laboratory Service Piping
221600 Laboratory Neutralization System
222620 Package Laboratory Vacuum Pump And Receiver
223300 Electric Domestic Water Heaters
223400 Fuel-Fired Domestic Water Heaters
224000 Plumbing Fixtures
224700 Drinking Fountains And Water Coolers
226119 Compressed Air Equipment
226700 Reagent Grade Water System
226710 Purified Water Piping

DIV. 23 HEATING VENTILATION AND AIR CONDITIONING

DIVISION 26 – ELECTRICAL

DIV. 27 COMMUNICATIONS

VOLUME 4 - GATEWAY SIGNAGE

DIVISION 31 – EARTHWORK

DIV. 32 EXTERIOR IMPROVEMENTS

DIV. 33 (NOT USED)

VOLUME 5 – OBSERVATION DRIVE EAST-WEST ROAD AND TRAFFIC CIRCLE

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 02 – EXISTING CONDITIONS

DIVISION 03 – CAST-IN-PLACE CONCRETE

DIVISION 22 - PLUMBING

DIVISION 33 – EARTHWORK

DIVISION 32 – EXTERIOR IMPROVEMENTS

DIVISION 33 – UTILITIES

END OF TABLE OF CONTENTS, PART B

SHEET LIST

CIVIL

GI-001	COVER SHEET
VF-100	EXISTING CONDITIONS COMPOSITE PLAN
VF-101	EXISTING CONDITIONS PLAN
VF-102	EXISTING CONDITIONS PLAN
CD-101	SITE DEMOLITION PLAN
CD-102	SITE DEMOLITION PLAN
CE-101	SOIL EROSION & SEDIMENT CONTROL PLAN - STAGE 1
CE-102	SOIL EROSION & SEDIMENT CONTROL PLAN - STAGE 1
CE-103	SOIL EROSION & SEDIMENT CONTROL PLAN - STAGE 2
CE-104	SOIL EROSION & SEDIMENT CONTROL PLAN - STAGE 2
CE-105	SOIL EROSION & SEDIMENT CONTROL PLAN - STAGE 3
CE-106	SOIL EROSION & SEDIMENT CONTROL PLAN - STAGE 3
CE-501	SOIL EROSION & SEDIMENT CONTROL NOTES & DETAILS
CE-502	SOIL EROSION & SEDIMENT CONTROL NOTES & DETAILS
CE-503	SOIL EROSION & SEDIMENT CONTROL NOTES & DETAILS
CE-504	SOIL EROSION & SEDIMENT CONTROL NOTES & DETAILS
CE-701	FOREST CONSERVATION NOTES & DETAILS
CG-101	OBSERVATION DRIVE: STORM DRAIN & PAVING PLAN
CG-102	OBSERVATION DRIVE: STORM DRAIN & PAVING PLAN
CG-103	OBSERVATION DRIVE: STORM DRAIN & PAVING PLAN
CG-104	OBSERVATION DRIVE: TRAFFIC CIRCLE ENLARGEMENT PLAN
CG-701	STORM DRAIN ANALYSIS DRAINAGE AREA MAP
CL-101	OBSERVATION DRIVE: STREET LIGHTING PLAN
CL-102	OBSERVATION DRIVE: STREET LIGHTING PLAN
CP-101	OBSERVATION DRIVE: STREET GRADE ESTABLISHMENT PLAN
CP-102	OBSERVATION DRIVE: STREET GRADE ESTABLISHMENT PLAN
CP-103	OBSERVATION DRIVE: STREET GRADE ESTABLISHMENT PLAN
CS-101	OBSERVATION DRIVE: PAVEMENT STRIPING & SIGNAGE PLAN
CS-102	OBSERVATION DRIVE: PAVEMENT STRIPING & SIGNAGE PLAN
CS-301	RETAINING WALL #1
CS-302	RETAINING WALL #2
CS-303	RETAINING WALL #3
CU-101	PUBLIC WATER & SEWER EXTENSION PLAN
CU-102	PUBLIC WATER & SEWER EXTENSION PLAN
CU-111	ON-SITE WATER & SEWER PLAN

CU-201 PUBLIC WATER & SEWER EXTENSION PROFILES

CW-101 STORMWATER MANAGEMENT PLAN - PLAN VIEW
CW-102 STORMWATER MANAGEMENT PLAN - PLAN VIEW
CW-201 STORMWATER MANAGEMENT PLAN - STORM DRAIN PROFILES
CW-202 STORMWATER MANAGEMENT PLAN - STORM DRAIN PROFILES
CW-203 STORMWATER MANAGEMENT PLAN - STORM DRAIN PROFILES
CW-301 STORMWATER MANAGEMENT PLAN - CROSS SECTIONS
CW-302 STORMWATER MANAGEMENT PLAN - CROSS SECTIONS
CW-303 STORMWATER MANAGEMENT PLAN - CROSS SECTIONS
CW-501 STORMWATER MANAGEMENT PLAN - DETAILS
CW-502 STORMWATER MANAGEMENT PLAN - DETAILS
CW-503 STORMWATER MANAGEMENT PLAN - DETAILS
CW-601 STORMWATER MANAGEMENT PLAN - SOIL BORING LOGS
CW-701 STORMWATER MANAGEMENT PLAN - DRAINAGE AREA MAP

FOREST CONSERVATION

FC-100 FOREST CONSERVATION PLAN
FC-101 FOREST CONSERVATION PLAN
FC-102 FOREST CONSERVATION PLAN
FC-103 FOREST CONSERVATION PLAN
FC-104 FOREST CONSERVATION PLAN
FC-105 FOREST CONSERVATION PLAN
FC-106 FOREST CONSERVATION PLAN
FC-107 FOREST CONSERVATION PLAN

LANDSCAPE

LP-101 LANDSCAPE PLAN
LP-102 DETAILED LANDSCAPE PLAN
LP-103 DETAILED LANDSCAPE PLAN
LP-104 DETAILED LANDSCAPE PLAN
LP-105 DETAILED LANDSCAPE PLAN

END OF SHEET LIST

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work under separate contracts.
4. Access to site.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and drawing conventions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of College's facilities.

1.3 PROJECT INFORMATION

A. Project Identification: Observation Drive East-West, Road Construction and Traffic Circle

1. Project Location: 202000 Observation Drive, Germantown, MD 20876.

B. Owner: Montgomery Community College

1. Owner's Representative: Cynthia Johnston, Director of Project Management
Montgomery College
Office of Central Facilities
40 West Gude Drive
Rockville, MD 20850

C. Architect/Engineer: A. Morton Thomas and Associates, 12750 Twinbrook Parkway, Rockville, MD 20852

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. Observation Drive East-West is the construction of a new 4-lane arterial roadway and traffic circle located on the Germantown Campus of Montgomery College. The project is the 3rd phase of a 3 phase construction project for the site infrastructure at the Germantown Campus. The project involves the construction of the new roadway, traffic circle, water extensions, sanitary sewer extensions, storm drainage, stormwater management facilities, erosion control, retaining walls, on-site water meter connections and landscaping.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.5 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

B. Preceding Work: Phase 1 of the project included site clearing, rough grading and minor demolition including a portion within the Observation Drive East-West project area. Work included related erosion control measures and established construction entrance for the project. Phase 1 work is now substantially complete.

C. Concurrent Work: The College has awarded separate contract(s) for the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.

1. Construction of Phase 1 B involves site work to construct a new parking lot; a new 4-lane public roadway within a new campus entrance; continuation of an inner campus 2-lane road which will connect existing campus roadways to form a complete campus loop road; mass grading for the project site including a portion of the Observation Drive East-West project area; relocation of a 24-inch WSSC water transmission main; other utility water including water, sanitary sewer, storm drainage, electric and communications; paving; stormwater management and landscaping.

2. Construction of the Bioscience Education Center building and associated site improvements.

3. Construction of a new Gateway Signage and entry feature just north of the proposed traffic circle.

1.6 ACCESS TO SITE

A. General: Contractor shall have full use of Observation Drive East-West project site for construction operations during construction period. Contractor's use of Project site is limited only by College's right to perform work or to retain other contractors on portions of Project.

B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Confine construction operations to areas within the Contract Limts.
2. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to College, College's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

a. Schedule deliveries to minimize use of driveways and entrances by construction operations.

b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.7 COORDINATION WITH OCCUPANTS

A. Full Owner Occupancy: College will occupy adjacent site and building(s) during entire construction period. Cooperate with College during construction operations to minimize conflicts and facilitate College usage. Perform the Work so as not to interfere with College's day-to-day operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from College and approval of authorities having jurisdiction.
2. Notify College not less than 72 hours in advance of activities that will affect College's operations.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

B. Related Requirements:

1. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
2. Section 014000 "Quality Requirements" for general testing and inspecting requirements.

1.3 DEFINITIONS

A. Unit price is an amount incorporated in the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Contactor shall engage a qualified Geotechnical Engineer and be responsible for all geotechnical costs.

D. College and Geotechnical Engineering Agency will verify measurements and quantities.

E. List of Unit Prices: A list of Unit Prices is included Price Proposal Form 00410 C. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

1. Provide unit prices to establish a fixed basis for costs for adding or changing specified quantities of work from those indicated in the contract drawings and specifications, when directed in writing by the College to make such changes. The unit prices shall include all labor, materials, equipment, overhead, bonds, insurance and profit.
2. Where the unit price schedule designates an estimated quantity for the work, Contactor shall indicate in the appropriate place on the Bid Form a total price for the work and a unit price, with the total price equal to the unit price times the estimated quantity stated.
3. This total price shall be included in the Total Bid Price for the work.

4. The Contract sum will be adjusted by Change Order by applying the bid unit price to the actual quantity of work in excess of, or less than, the quantity stated in the bid.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012200

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. Requests for Information (RFIs).
4. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

A. RFI: Request from College, Architect/Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Submit in accordance with the Instructions to Bidders a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home,

office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for College and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as College's property.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

    a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
    b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
    c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
    e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
    f. Indicate required installation sequences.
    g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect/Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

1.7 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in accordance with the Montgomery College General Condition Section 4.2.

1. Architect/Engineer will return RFIs submitted to Architect/Engineer by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect/Engineer.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716. Software-generated form with substantially the same content as indicated above, acceptable to Architect/Engineer.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Architect/Engineer's Action: Architect/Engineer will review each RFI, determine action required, and respond. Allow Five working days for Architect/Engineer's response for each RFI. RFIs received by Architect/Engineer after 3:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for approval of Contractor's means and methods.
d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.
f. Requests for interpretation of Architect/Engineer's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect/Engineer's action may include a request for additional information, in which case Architect/Engineer's time for response will date from time of receipt of additional information.
3. Architect/Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum shall follow procedures outlined in the Montgomery College General Conditions.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log at the progress meetings. Include the following:

1. Project name.
2. Name and address of Contractor.
3. RFI number including RFIs that were returned without action or withdrawn.
4. RFI description.
5. Date the RFI was submitted.
6. Date Architect/Engineer's response was received.

F. On receipt of Architect/Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect/Engineer within Five days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify College and Architect/Engineer of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including College and Architect/Engineer, within three days of the meeting.

B. Preconstruction Conference: Architect/Engineer and College will schedule and conduct a preconstruction conference before starting construction.

1. Conduct the conference to review responsibilities and personnel assignments.
2. Attendees: Authorized representatives of College, Architect/Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Tentative construction schedule.
    b. Phasing.
    c. Critical work sequencing and long-lead items.
    d. Designation of key personnel and their duties.
    e. Lines of communications.
    f. Procedures for processing field decisions and Change Orders.
    g. Procedures for RFIs.
    h. Procedures for testing and inspecting.
    i. Procedures for processing Applications for Payment.
    j. Distribution of the Contract Documents.
    k. Submittal procedures.
    l. Preparation of record documents.
    m. Use of the premises.
    n. Work restrictions.
    o. Working hours.
    p. College's occupancy requirements.
    q. Responsibility for temporary facilities and controls.
    r. Procedures for disruptions and shutdowns.
    s. Construction waste management and recycling.
    t. Parking availability.
    u. Office, work, and storage areas.
    v. Equipment deliveries and priorities.
    w. First aid.
    x. Security.
    y. Progress cleaning.

4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect/Engineer of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.

e. Purchases.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility requirements.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to College and Architect/Engineer, but no later than 30days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of College, Architect/Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of record documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Submittal of written warranties.
d. Requirements for preparing operations and maintenance data.
e. Requirements for delivery of material samples, attic stock, and spare parts.
f. Requirements for demonstration and training.
g. Preparation of Contractor's punch list.
h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
i. Submittal procedures.
j. Coordination of separate contracts.
k. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at no less than biweekly intervals or as determined.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of College and Architect/Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

        1) Review schedule for next period.

    b. Review present and future needs of each entity present, including the following:

        1) Interface requirements.
        2) Sequence of operations.
        3) Status of submittals.
        4) Deliveries.
        5) Off-site fabrication.
        6) Access.
        7) Site utilization.
        8) Temporary facilities and controls.
        9) Quality and work standards.
        10) Status of correction of deficient items.
        11) Field observations.
        12) Status of RFIs.
        13) Status of proposal requests.
        14) Pending changes.
        15) Status of Change Orders.
        16) Pending claims and disputes.
        17) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

    a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's construction schedule.
2. Construction schedule updating reports.
3. Daily construction reports.
4. Material location reports.
5. Site condition reports.
6. Special reports.

B. Related Requirements:

1. Section 013300 "Submittal Procedures" for submitting schedules and reports.
2. Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by College and Architect/Engineer.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either College or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF electronic file.
3. Two paper copies.

B. Startup construction schedule.

1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.

F. Construction Schedule Updating Reports: Submit monthly with Applications for Payment.

1. Construction Schedule Updating Reports shall be furnished monthly whether or not Contractor submits an application for payment in that month.

G. Daily Construction Reports: Submit at weekly intervals.

H. Site Condition Reports: Submit at time of discovery of differing conditions.

I. Special Reports: Submit at time of unusual event.

J. Qualification Data: For scheduling consultant.

K. Progress Documents: The Contractor shall keep one complete set of all Drawings, Specifications, construction progress schedule, and shop drawings at the job-site and in good order. As the Work progresses, the Contractor shall keep a complete and accurate record of all changes or deviations from the Contract Documents, indicating the Work as actually installed. All underground utility locations associated with the scope of work, or revealed during the conduct of the work, shall be recorded by the Contractor's surveyor and referenced to a campus benchmark provided by the College. All such changes shall be neatly and correctly shown on black line prints of the drawings affected, or in the Specifications, with appropriate supplemental notes. This record set of prints of Drawings, shop drawings and Specifications shall be kept at the job site for inspection by the College's Project Manager and Architect/Engineer.

1.5 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect/Engineer's request.

1.6 COORDINATION

A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect/Engineer.
2. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect/Engineer's administrative procedures necessary for certification of Substantial Completion.
3. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

C. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and Contract Time.

D. Recovery Schedule: Whenever the project shall be behind scheduled or alleged behind schedule by either party to be behind schedule, the College may require the Contractor to furnish, at no additional cost to the College, revised schedule information (hereinafter called a "recovery schedule") showing how the Contractor will furnish their work by the Contract completion date. Indicate changes to the working hours, working days, crew sizes, and equipment required to achieve compliance.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Preliminary Schedule:

1. The Contractor shall agree to comply with the Preliminary Project Schedule prepared by the College and included in the Contract Documents or with the Contractor's Proposed Project Schedule, if one was required as part of the Contractor's proposal submission. Agreement by the Contractor to comply with the Preliminary Project Schedule or Contactor's Proposed Project Scheduled also means agreement by the Contractor to comply with subsequent reasonable updates prepared or requested by the College.
2. Within 14 days from the execution of the Contract, Contractor must submit for approval, preliminary schedule information outlining all activities for the Contractor's work as my be reasonably requested by the College's Project Manager. Coordinate schedule information with milestones indicated in the Preliminary Project Schedule. This preliminary information must be approved prior to the first Application for Payment being processed. Include each significant construction activity, coordinate each activity with other activities and schedule each construction activity in proper sequence. This College's Project Manager may decline to issue a Notice to Proceed until Contractor shal submitted the required schedule information and it is approved by the College's Project Manager. Nothing in this section shall be construed to require the College's Project Manager to issue a Notice to Proceed when the required schedule information has submitted and approved.
3. With the Submission of the preliminary schedule information, include a listing by date of the submission of all submittals required. Identify those required to maintain orderly progress of the Work, and those required because of long lead time for manufacturing or fabrication.

C. CPM Schedule: Prepare Contractor's construction schedule using a time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for Contract execution.

    a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect/Engineer's approval of the schedule.

2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.

3. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

    a. Preparation and processing of submittals.
    b. Mobilization and demobilization.
    c. Delivery.
    d. Utility interruptions.
    e. Installation.
    f. Testing.
    g. Punch list and final completion.
    h. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

    a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Dollar value of activity (coordinated with the schedule of values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

2.3 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. Approximate count of personnel at Project site.
3. Equipment at Project site.
4. Material deliveries.
5. High and low temperatures and general weather conditions, including presence of rain or snow.
6. Accidents.
7. Meetings and significant decisions.
8. Unusual events (see special reports).
9. Stoppages, delays, shortages, and losses.
10. Meter readings and similar recordings.
11. Emergency procedures.
12. Orders and requests of authorities having jurisdiction.
13. Change Orders received and implemented.
14. Services connected and disconnected.
15. Equipment or system tests and startups.
16. Substantial Completions authorized.

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to College within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise College in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect/Engineer, College, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Periodic construction photographs.
3. Final completion construction photographs.

B. Related Requirements:

1. Section 012200 "Unit Prices" for procedures for unit prices for extra photographs.
2. Section 013300 "Submittal Procedures" for submitting photographic documentation.
3. Section 017700 "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.
4. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of College's personnel.
5. Section 311000 "Site Clearing" for photographic documentation before site clearing operations commence.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For photographer.

B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

C. Digital Photographs: Submit image files within seven days of taking photographs.

1. Digital Camera: Minimum sensor resolution of 8 megapixels.
2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
3. Identification: Provide the following information with each image description in file metadata tag:

a. Name of Project.
b. Name and contact information for photographer.
c. Name of Architect/Engineer.
d. Name of Contractor.
e. Date photograph was taken.

f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
g. Unique sequential identifier keyed to accompanying key plan.

1.4 QUALITY ASSURANCE

A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.5 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to College for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8megapixels, and at an image resolution of not less than 3200 by 2400 pixels.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

A. Photographer: Engage a qualified photographer to take construction photographs.

B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

1. Date and Time: Include date and time in file name for each image.
2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect/Engineer.

D. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect/Engineer.

1. Flag construction limits before taking construction photographs.
2. Take 8 photographs to show existing conditions adjacent to property before starting the Work.
3. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

E. Periodic Construction Photographs: Take 12 photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

F. Final Completion Construction Photographs: Take 8 color photographs after date of Substantial Completion for submission as project record documents. Architect/Engineer will inform photographer of desired vantage points.

1. Do not include date stamp.

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
2. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
4. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of College's personnel.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect/Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect/Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and

delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect/Engineer and College and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect/Engineer's and College's final release or approval.
    g. Scheduled date of fabrication.
    h. Scheduled dates for purchasing.
    i. Scheduled dates for installation.
    j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect/Engineer and College reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. The College's Project Manager and Architect/Engineer will examine the shop drawings and product data submittals with reasonable promptness. The College's Project Manager and Architect/Engineer will not whether they are approved, approved with corrections and/or conditions, or rejected. The Architect/Engineer will return the shop drawings and product data submittals with the final action to the Contractor and also provide one copy each to the College and College's Project Manager.

C. Processing Time: The Contractor must allow the Architect/Engineer, College's Project Manager at least 14 calendar days following receipt of each submittal or re-submittal of shop drawings and product data

submittals to review the documents and respond to the Contractor. Items requiring longer than 14 calendar days of review time will be identified in the Specifications. The minimum time allowed for the Architect/Engineer, College's Project Manager to review the submittal shall be increased to the extent that additional time for review is needed due to the fault or the responsibility of the Contractor or its Subcontractors and suppliers. The Contractor will be notified of the cause of the delay and advised on how long it will take to complete the review; provided, however, that mere failure to give the Contractor such notice shall not entitle the Contractor to compensation or a time extension.

D. Electronic Submittals: At the Contractor's option and if mutually acceptable by the Architect/Engineer and College, electronic submittals will be accepted for submittal documentation up to 11"x17" format. Samples, color charts, and shop drawings exceeding 11"x17" format must be submitted in hard copy. Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to College, containing the following information:

    a. Project name.
    b. Date.
    c. Name and address of Architect.
    d. Name of Contractor.
    e. Name of firm or entity that prepared submittal.
    f. Names of subcontractor, manufacturer, and supplier.
    g. Category and type of submittal.
    h. Submittal purpose and description.
    i. Specification Section number and title.
    j. Specification paragraph number or drawing designation and generic name for each of multiple items.
    k. Drawing number and detail references, as appropriate.
    l. Location(s) where product is to be installed, as appropriate.
    m. Related physical samples submitted directly.
    n. Indication of full or partial submittal.
    o. Transmittal number, numbered consecutively.
    p. Submittal and transmittal distribution record.
    q. Other necessary identification.
    r. Remarks.

E. Options: Identify options requiring selection by Architect and College.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

B. With each submittal indicated below, provide on copy to the College coincident with submission to the Architect/Engineer.

1. Hard Copy Action Submittals: Submit a minimum of 5 paper copies of each submittal. Architect/Engineer will retain one copy for the Architect/Engineer, one for the Consultant, and two for the College, and will return the remaining copies.
2. Submit electronic submittals as PDF electronic files by email or post to FTP site specifically established for Project.

    a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

3. Informational Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect and College will not return copies.
4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

    a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
    b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

C. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.

e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:

a. PDF electronic file.

D. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:

a. PDF electronic file.

E. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

a. Generic description of Sample.
b. Product name and name of manufacturer.
c. Sample source.
d. Number and title of applicable Specification Section.
e. Specification paragraph number and generic name of each item.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
b. Samples not incorporated into the Work, or otherwise designated as College's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.

        1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.

F. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Submit product schedule in the following format:

    a. PDF electronic file.

G. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."

H. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."

J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."

K. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and Colleges, and other information specified.

M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

R. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

V. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect and College.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:

1. Approved
2. Approved as Noted
3. Revise and Resubmit
4. Rejected

B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect/Engineer, College, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect/Engineer.

C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect/Engineer for a decision before proceeding.

1.5 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.

2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.6 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect/Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project Quality Control Manager shall not have Project responsibilities.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect/Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.7 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.

6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For College's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.8 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.9 QUALITY CONTROL

A. College Responsibilities: Where quality-control services are indicated as College's responsibility, College will engage a qualified testing agency to perform these services.

1. College will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to College are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

a. Contractor shall not employ same entity engaged by College, unless agreed to in writing by College.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Architect/Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect/Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to College, Architect/Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect/Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect/Engineer's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect/Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect/Engineer's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect/Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AABC	Associated Air Balance Council www.aabc.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AASHTO	American Association of State Highway and Transportation Officials www.transportation.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists www.aatcc.org	(919) 549-8141
ABMA	American Bearing Manufacturers Association www.americanbearings.org	(202) 367-1155
ACI	American Concrete Institute (Formerly: ACI International) www.concrete.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955

AHRI	Air-Conditioning, Heating, and Refrigeration Institute (The) www.ahrinet.org	(703) 524-8800
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.aia.org	(800) 242-3837 (202) 626-7300
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction www.aitc-glulam.org	(303) 792-9559
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts, Inc. www.aosaseed.com	(607) 256-3313
APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(239) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute (See AHRI)	
ARI	American Refrigeration Institute (See AHRI)	
ARMA	Asphalt Roofing Manufacturers Association www.asphaltroofing.org	(202) 207-0917
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)	
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400

ASME	ASME International (American Society of Mechanical Engineers) www.asme.org	(800) 843-2763 (973) 882-1170
ASSE	American Society of Safety Engineers (The) www.asse.org	(847) 699-2929
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9500
ATIS	Alliance for Telecommunications Industry Solutions www.atis.org	(202) 628-6380
AWEA	American Wind Energy Association www.awea.org	(202) 383-2500
AWI	Architectural Woodwork Institute www.awinet.org	(571) 323-3636
AWMAC	Architectural Woodwork Manufacturers Association of Canada www.awmac.com	(403) 453-7387
AWPA	American Wood Protection Association (Formerly: American Wood-Preservers' Association) www.awpa.com	(205) 733-4077
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The) www.gobrick.com	(703) 620-0010
BICSI	BICSI, Inc. www.bicsi.org	(800) 242-7405 (813) 979-1991
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association) www.bifma.com	(616) 285-3963
BISSC	Baking Industry Sanitation Standards Committee www.bissc.org	(866) 342-4772
BOCA	BOCA (Building Officials and Code Administrators International Inc.) (See ICC)	

BWF	Badminton World Federation (Formerly: International Badminton Federation) www.bwfbadminton.org	60 3 9283 7155
CDA	Copper Development Association www.copper.org	(800) 232-3282 (212) 251-7200
CEA	Canadian Electricity Association www.electricity.ca	(613) 230-9263
CEA	Consumer Electronics Association www.ce.org	(866) 858-1555 (703) 907-7600
CFFA	Chemical Fabrics & Film Association, Inc. www.chemicalfabricsandfilm.com	(216) 241-7333
CFSEI	Cold-Formed Steel Engineers Institute www.cfsei.org	(866) 465-4732 (202) 263-4488
CGA	Compressed Gas Association www.cganet.com	(703) 788-2700
CIMA	Cellulose Insulation Manufacturers Association www.cellulose.org	(888) 881-2462 (937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute www.cispi.org	(404) 622-0073
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CPA	Composite Panel Association www.pbmdf.com	(703) 724-1128
CRI	Carpet and Rug Institute (The) www.carpet-rug.org	(706) 278-3176
CRRC	Cool Roof Rating Council www.coolroofs.org	(866) 465-2523 (510) 485-7175
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(800) 328-6306 (847) 517-1200
CSA	Canadian Standards Association www.csa.ca	(800) 463-6727 (416) 747-4000
CSA	CSA International (Formerly: IAS - International Approval Services) www.csa-international.org	(866) 797-4272 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300

CSSB	Cedar Shake & Shingle Bureau www.cedarbureau.org	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
CWC	Composite Wood Council (See CPA)	
DASMA	Door and Access Systems Manufacturers Association www.dasma.com	(216) 241-7333
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
ECA	Electronic Components Association www.ec-central.org	(703) 907-8024
ECAMA	Electronic Components Assemblies & Materials Association (See ECA)	
EIA	Electronic Industries Alliance (See TIA)	
EIMA	EIFS Industry Members Association www.eima.com	(800) 294-3462 (703) 538-1616
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	ESD Association (Electrostatic Discharge Association) www.esda.org	(315) 339-6937
ESTA	Entertainment Services and Technology Association (See PLASA)	
EVO	Efficiency Valuation Organization www.evo-world.org	(415) 367-3643 44 20 88 167 857
FIBA	Fédération Internationale de Basketball (The International Basketball Federation) www.fiba.com	41 22 545 00 00
FIVB	Fédération Internationale de Volleyball (The International Volleyball Federation) www.fivb.org	41 21 345 35 45
FM Approvals	FM Approvals LLC www.fmglobal.com	(781) 762-4300
FM Global	FM Global (Formerly: FMG - FM Global) www.fmglobal.com	(401) 275-3000

FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. www.floridaroof.com	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council U.S. www.fscus.org	(612) 353-4511
GA	Gypsum Association www.gypsum.org	(301) 277-8686
GANA	Glass Association of North America www.glasswebsite.com	(785) 271-0208
GS	Green Seal www.greenseal.org	(202) 872-6400
HI	Hydraulic Institute www.pumps.org	(973) 267-9700
HI/GAMA	Hydronics Institute/Gas Appliance Manufacturers Association (See AHRI)	
HMMA	Hollow Metal Manufacturers Association (See NAAMM)	
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAPSC	International Association of Professional Security Consultants www.iapsc.org	(415) 536-0288
IAS	International Approval Services (See CSA)	
ICBO	International Conference of Building Officials (See ICC)	
ICC	International Code Council www.iccsafe.org	(888) 422-7233 (202) 370-1800
ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(770) 830-0369
ICPA	International Cast Polymer Alliance www.icpa-hq.org	(703) 525-0511
ICRI	International Concrete Repair Institute, Inc. www.icri.org	(847) 827-0830
IEC	International Electrotechnical Commission	41 22 919 02 11

	www.iec.ch	
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IES	Illuminating Engineering Society (Formerly: Illuminating Engineering Society of North America) www.ies.org	(212) 248-5000
IESNA	Illuminating Engineering Society of North America (See IES)	
IEST	Institute of Environmental Sciences and Technology www.iest.org	(847) 981-0100
IGMA	Insulating Glass Manufacturers Alliance www.igmaonline.org	(613) 233-1510
IGSHPA	International Ground Source Heat Pump Association www.igshpa.okstate.edu	(405) 744-5175
ILI	Indiana Limestone Institute of America, Inc. www.iliai.com	(812) 275-4426
Intertek	Intertek Group (Formerly: ETL SEMCO; Intertek Testing Service NA) www.intertek.com	(800) 967-5352
ISA	International Society of Automation (The) (Formerly: Instrumentation, Systems, and Automation Society) www.isa.org	(919) 549-8411
ISAS	Instrumentation, Systems, and Automation Society (The) (See ISA)	
ISFA	International Surface Fabricators Association (Formerly: International Solid Surface Fabricators Association) www.isfanow.org	(877) 464-7732 (801) 341-7360
ISO	International Organization for Standardization www.iso.org	41 22 749 01 11
ISSFA	International Solid Surface Fabricators Association (See ISFA)	
ITU	International Telecommunication Union www.itu.int/home	41 22 730 51 11
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LMA	Laminating Materials Association (See CPA)	
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864

MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MCA	Metal Construction Association www.metalconstruction.org	(847) 375-4718
MFMA	Maple Flooring Manufacturers Association, Inc. www.maplefloor.org	(888) 480-9138
MFMA	Metal Framing Manufacturers Association, Inc. www.metalframingmfg.org	(312) 644-6610
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-institute.com	(440) 250-9222
MMPA	Moulding & Millwork Producers Association (Formerly: Wood Moulding & Millwork Producers Association) www.wmmpa.com	(800) 550-7889 (530) 661-9591
MPI	Master Painters Institute www.paintinfo.com	(888) 674-8937 (604) 298-7578
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.org	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(630) 942-6591
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(800) 797-6223 (281) 228-6200
NADCA	National Air Duct Cleaners Association www.nadca.com	(202) 737-2926
NAIMA	North American Insulation Manufacturers Association www.naima.org	(703) 684-0084
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848
NCAA	National Collegiate Athletic Association (The) www.ncaa.org	(317) 917-6222
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association	(301) 657-3110

	www.necanet.org	
NeLMA	Northeastern Lumber Manufacturers Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(888) 300-6382 (269) 488-6382
NFHS	National Federation of State High School Associations www.nfhs.org	(317) 972-6900
NFPA	NFPA (National Fire Protection Association) www.nfpa.org	(800) 344-3555 (617) 770-3000
NFPA	NFPA International (See NFPA)	
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-1776
NHLA	National Hardwood Lumber Association www.nhla.com	(800) 933-0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association (See NWFA)	
NOMMA	National Ornamental & Miscellaneous Metals Association www.nomma.org	(888) 516-8585
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
NSPE	National Society of Professional Engineers www.nspe.org	(703) 684-2800
NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
NTMA	National Terrazzo & Mosaic Association, Inc. (The) www.ntma.com	(800) 323-9736
NWFA	National Wood Flooring Association	(800) 422-4556

	www.nwfa.org	(636) 519-9663
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDI	Plumbing & Drainage Institute www.pdionline.org	(800) 589-8956 (978) 557-0720
PLASA	PLASA (Formerly: ESTA - Entertainment Services and Technology Association) www.plasa.org	(212) 244-1505
RCSC	Research Council on Structural Connections www.boltcouncil.org	
RFCI	Resilient Floor Covering Institute www.rfci.com	(706) 882-3833
RIS	Redwood Inspection Service www.redwoodinspection.com	(925) 935-1499
SAE	SAE International (Society of Automotive Engineers) www.sae.org	(877) 606-7323 (724) 776-4841
SBCCI	Southern Building Code Congress International, Inc. (See ICC)	
SCTE	Society of Cable Telecommunications Engineers www.scte.org	(800) 542-5040 (610) 363-6888
SDI	Steel Deck Institute www.sdi.org	(847) 458-4647
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010
SEFA	Scientific Equipment and Furniture Association www.sefalabs.com	(877) 294-5424 (516) 294-5424
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)	
SIA	Security Industry Association www.siaonline.org	(866) 817-8888 (703) 683-2075
SJI	Steel Joist Institute www.steeljoist.org	(843) 293-1995
SMA	Screen Manufacturers Association www.smainfo.org	(773) 636-0672
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980

SMPTE	Society of Motion Picture and Television Engineers www.smpte.org	(914) 761-1100
SPFA	Spray Polyurethane Foam Alliance www.sprayfoam.org	(800) 523-6154
SPIB	Southern Pine Inspection Bureau www.spib.org	(850) 434-2611
SPRI	Single Ply Roofing Industry www.spri.org	(781) 647-7026
SRCC	Solar Rating and Certification Corporation www.solar-rating.org	(321) 638-1537
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333
SWPA	Submersible Wastewater Pump Association www.swpa.org	(847) 681-1868
TCA	Tilt-Up Concrete Association www.tilt-up.org	(319) 895-6911
TCNA	Tile Council of North America, Inc. (Formerly: Tile Council of America) www.tileusa.com	(864) 646-8453
TEMA	Tubular Exchanger Manufacturers Association, Inc. www.tema.org	(914) 332-0040
TIA	Telecommunications Industry Association (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance) www.tiaonline.org	(703) 907-7700
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance (See TIA)	
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
TPI	Truss Plate Institute www.tpinst.org	(703) 683-1010

TPI	Turfgrass Producers International www.turfgrasssod.org	(800) 405-8873 (847) 649-5555
TRI	Tile Roofing Institute www.tileroofing.org	(312) 670-4177
UBC	Uniform Building Code (See ICC)	
UL	Underwriters Laboratories Inc. www.ul.com	(877) 854-3577
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USAV	USA Volleyball www.usavolleyball.org	(888) 786-5539 (719) 228-6800
USGBC	U.S. Green Building Council www.usgbc.org	(800) 795-1747
USITT	United States Institute for Theatre Technology, Inc. www.usitt.org	(800) 938-7488 (315) 463-6463
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association www.wcmanet.org	(212) 297-2122
WDMA	Window & Door Manufacturers Association www.wdma.com	(800) 223-2301 (312) 321-6802
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California) www.wicnet.org	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Association (See MMPA)	
WSRCA	Western States Roofing Contractors Association www.wsrca.com	(800) 725-0333 (650) 938-5441
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

DIN	Deutsches Institut für Normung e.V.	49 30 2601-0

	www.din.de	
IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
ICC	International Code Council www.iccsafe.org	(888) 422-7233
ICC-ES	ICC Evaluation Service, LLC www.icc-es.org	(800) 423-6587 (562) 699-0543

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

COE	Army Corps of Engineers www.usace.army.mil	(202) 761-0011
CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-7923
DOC	Department of Commerce National Institute of Standards and Technology www.nist.gov	(301) 975-4040
DOD	Department of Defense http://dodssp.daps.dla.mil	(215) 697-2664
DOE	Department of Energy www.energy.gov	(202) 586-9220
EPA	Environmental Protection Agency www.epa.gov	(202) 272-0167
FAA	Federal Aviation Administration www.faa.gov	(866) 835-5322
FG	Federal Government Publications www.gpo.gov	(202) 512-1800
GSA	General Services Administration www.gsa.gov	(800) 488-3111 (202) 619-8925
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
LBL	Lawrence Berkeley National Laboratory Environmental Energy Technologies Division http://eetd.lbl.gov	(510) 486-4000
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742
SD	Department of State	(202) 647-4000

	www.state.gov	
TRB	Transportation Research Board National Cooperative Highway Research Program www.trb.org	(202) 334-2934
USDA	Department of Agriculture Agriculture Research Service U.S. Salinity Laboratory www.ars.usda.gov	(202) 720-3656
USDA	Department of Agriculture Rural Utilities Service www.usda.gov	(202) 720-2791
USDJ	Department of Justice Office of Justice Programs National Institute of Justice www.ojp.usdoj.gov	(202) 307-0703
USP	U.S. Pharmacopeia www.usp.org	(800) 227-8772 (301) 881-0666
USPS	United States Postal Service www.usps.com	(202) 268-2000

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CFR	Code of Federal Regulations Available from Government Printing Office www.gpo.gov/fdsys	(866) 512-1800 (202) 512-1800
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	(215) 697-2664
DSCC	Defense Supply Center Columbus (See FS)	
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	(215) 697-2664
	Available from Defense Standardization Program www.dsp.dla.mil	
	Available from General Services Administration www.gsa.gov	(800) 488-3111 (202) 619-8925

	Available from National Institute of Building Sciences/Whole Building Design Guide www.wbdg.org/ccb	(202) 289-7800
MILSPEC	Military Specification and Standards (See DOD)	
USAB	United States Access Board www.access-board.gov	(800) 872-2253 (202) 272-0080
USATBCB	U.S. Architectural & Transportation Barriers Compliance Board (See USAB)	

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CBHF	State of California Department of Consumer Affairs Bureau of Electronic Appliance and Repair, Home Furnishings and Thermal Insulation www.bearhfti.ca.gov	(800) 952-5210 (916) 574-2041
CCR	California Code of Regulations Office of Administrative Law California Title 24 Energy Code www.calregs.com	(916) 323-6225
CDHS	California Department of Health Care Services (Formerly: California Department of Health Services) (See CCR)	
CDPH	California Department of Public Health Indoor Air Quality Program www.cal-iaq.org	
CPUC	California Public Utilities Commission www.cpuc.ca.gov	(800) 848-5580 (415) 703-2782
SCAQMD	South Coast Air Quality Management District www.aqmd.gov	(909) 396-2000
TFS	Texas Forest Service Forest Resource Development and Sustainable Forestry http://txforestservice.tamu.edu	 (979) 458-6606

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.
2. Section 321216 "Asphalt Paving" for construction and maintenance of asphalt pavement for temporary roads and paved areas.
3. Section 321313 "Concrete Paving" for construction and maintenance of cement concrete pavement for temporary roads and paved areas.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, College's construction forces, Architect/Engineer, testing agencies, and authorities having jurisdiction.

B. Utility Services from Existing Systems: The Contractor shall include in the Contract Sum all temporary connections and extensions of services as required for construction operations, separately meter and pay for utilities (electricity, water, sewer and telephone) consumed, and remove the temporary installation and connections when no longer required.

1.4 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before College's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide concrete bases for supporting posts.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Common-Use Field Office: Of sufficient size to accommodate needs of College, Architect/Engineer, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- square tack and marker boards.
3. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F
4. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, College, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Connect to College's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to College. At Substantial Completion, restore these facilities to condition existing before initial use.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Toilets: Use of College's existing toilet facilities will not be permitted.

3.3 SUPPORT FACILITIES INSTALLATION

A. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

B. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 312000 "Earth Moving."
3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Section 321216 "Asphalt Paving."

C. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

E. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

    a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touchup signs so they are legible at all times.

F. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 011000 "Summary."

C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant- protection zones.
2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."

F. Site Enclosure Fence: Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.

1. Extent of Fence: As indicated on Drawings.
2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to College.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. College reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 015639 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Approved Forest Conservation Plan, MR2010711

1.2 SUMMARY

A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary site fencing.
2. Division 31 Section "Site Clearing" for removing existing trees and shrubs.

1.3 DEFINITIONS

A. Caliper: Diameter of a trunk measured by a diameter tape at 6 inches above the ground for trees up to, and including, 4-inch size; and 12 inches above the ground for trees larger than 4-inch size.

B. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

C. Tree-Protection Zone: Area surrounding individual trees or groups of trees to remain during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated. Additional tree protection zones are those areas enclosed by tree protection fence, installed in the location and manner shown on the plans.

D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each type of the following:

1. Organic Mulch: 1-quart volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
2. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components.
3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

C. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

4. Species and size of tree.
5. Location on site plan. Include unique identifier for each.
6. Reason for pruning.
7. Description of pruning to be performed.
8. Description of maintenance following pruning.

C. Qualification Data: For qualified arborist and tree service firm.

D. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

E. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

F. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.5 QUALITY ASSURANCE

A. Arborist Qualifications: Certified Arborist as certified by ISA and Maryland Licensed Tree Expert.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
b. Enforcing requirements for protection zones.
c. Arborist's responsibilities.
d. Field quality control.

1.6 PROJECT CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.

3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of weeds, roots, and toxic and other nonsoil materials.

1. Obtain topsoil only from well-drained sites where topsoil is 4 inches deep or more; do not obtain from bogs or marshes.

B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood
2. Size Range: 3 inches maximum, 1/2 inch minimum.
3. Color: Natural.

C. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements.

1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch opening, 0.148-inch diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch OD line posts, and 2-7/8-inch OD corner and pull posts with 1-5/8-inch OD top and 0.177-inch diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

a. Height: 4 feet minimum.

D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: As shown on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag each tree trunk at 54 inches above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

C. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas as indicated.

1. Apply organic mulch as indicated on drawings. Do not place mulch within 6 inches of tree trunks.

3.3 TREE- AND PLANT-PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Fencing: As indicated on the drawings.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations as shown on drawings.

C. Maintain protection zones free of weeds and trash.

D. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

E. Maintain protection-zone fencing and signage in good condition as acceptable to Landscape Architect and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Division 31 Section "Earth Moving."

B. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.

C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.

D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

A. Prune roots that are affected by temporary and permanent construction. Prune roots as shown on Drawings and as follows:

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Division 31 Section "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune roots as shown on stress reduction measure details, by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.6 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches as shown on Drawings and as follows:

1. Pruning Standards: Prune trees according to ANSI A300 (Part 1).

2. Cut branches with sharp pruning instruments; do not break or chop.
3. Do not apply pruning paint to wounds.

B. Chip removed branches and dispose of off-site.

3.7 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

C. Minor Fill within Protection Zone: Where existing grade is 3 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

3.8 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.9 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

1. Submit details of proposed root cutting and tree and shrub repairs.
2. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
4. Perform repairs within 24 hours.
5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.

B. Trees: Remove and replace trees indicated to remain that die or are damaged during construction operations to such an extent that Landscape Architect/Arborist determines they are incapable of recovering to normal growth patterns.

1. Provide new trees of same size and species as those being replaced.

2. Plant and maintain new trees as specified in Division 32 Section "Plants."

C. Soil Aeration: Where directed by Landscape Architect/Arborist, aerate surface soil compacted during construction. Aerate 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augered soil and sand.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off College's property.

END OF SECTION 015639

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:
1. Section 014200 "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Architect/Engineer's Action: If necessary, Architect/Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request.

Architect/Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
b. Use product specified if Architect/Engineer does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect/Engineer will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by College's construction forces. Coordinate location with College.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to College.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for College.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. College reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect/Engineer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

3. Products:
   a. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.

4. Manufacturers:
   a. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.

5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

C. Visual Matching Specification: Where Specifications require "match Architect/Engineer's sample", provide a product that complies with requirements and matches Architect/Engineer's sample. Architect/Engineer's decision will be final on whether a proposed product matches.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect/Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect/Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

1. Conditions for Consideration: Refer to Montgomery College General Conditions.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Protection of installed construction.
5. Correction of the Work.

B. Related Requirements:

1. Section 011000 "Summary" for limits on use of Project site.
2. Section 013300 "Submittal Procedures" for submitting surveys.
3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of College-accepted deviations from indicated lines and levels, and final cleaning.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor.

B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.

1.5 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect/Engineer for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Local utility and College that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect/Engineer and College according to requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect/Engineer promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architectwhen deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

B. Site: Maintain Project site free of waste materials and debris.

C. Installed Work: Keep installed work clean. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

D. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

1.4 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

1.6 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
2. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from College's property and legally dispose of them.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for submitting final completion construction photographic documentation.
2. Section 017300 "Execution" for progress cleaning of Project site.
3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
4. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
5. Section 017900 "Demonstration and Training" for requirements for instructing College's personnel.

1.3 ACTION SUBMITTALS

A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 > days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting College unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise College of pending insurance changeover requirements.
2. Perform preventive maintenance on equipment used prior to Substantial Completion.
3. Instruct College's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
4. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
5. Complete final cleaning requirements.

D. Inspection: When the Work is substantially completed, the Contractor shall notify the College’s Project Manager and the Architect/Engineer in writing that the Work will be ready for final inspection and testing on a definite date. Reasonable notice shall be given by the Contractor to permit the College’s Project Manager and Architect/Engineer to schedule the final inspection. On receipt of request, Architect/Engineer and College will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor’s list or additional items indentified by Architect/Engineer, that must be completed or corrected before certificate will be issued.

1. Resinspections: Request reinspection when the Work indentified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspections will form the basis of requirements for final completion.

E. List of Incomplete Items (Punch List): Following Inspections, Architect/Engineer will issue a list of Incomplete Items (Punch List).

F. If it is determined that Substantial Completion has been achieved, the College’s Project Manager shall fix the time within which the Contractor shall complete any remaining items of Work which will be indicated on the punch list. If the Contractor fails to complete the remaining items so listed in the time stipulated, the College shall have the undisputed right to complete the Work at the Contractor’s expense. The Contractor may be required to complete multiple punch lists until the Contract is performed in its entirety. Failure to complete punch list work in a timely manner shall constitute grounds for termination of the

Contract for default. Final payment shall not be made until all Contract work, including all punch list work is complete to the satisfaction of the College's Project Manager.

1.7 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to College's General Conditions.
2. Certified List of Incomplete Items: Submit certified copy of Architect/Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect/Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

1.8 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect/Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit College's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Clean site.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean.
c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access.
f. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
g. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Operation manuals for systems, subsystems, and equipment.
3. Product maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect/Engineer will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect/Engineer.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
b. Enable inserted reviewer comments on draft submittals.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Architect/Engineer will return two copies.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30days before commencing demonstration and training. Architect/Engineer will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect/Engineer will return copy with comments.

1. Correct or revise each manual to comply with Architect/Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Architect/Engineer's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.

9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.3 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.

2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by College's operating personnel.

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared record Drawings in Section 017839 "Project Record Documents."

F. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:
1. Section 017700 "Closeout Procedures" for general closeout procedures.
2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit three set(s) of marked-up record prints.

B. Record Specifications: Submit three paper copies of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit three paper copies of each submittal.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit three paper copies of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or

entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Locations and depths of underground utilities.
d. Revisions to routing of piping and conduits.
e. Changes made by Change Order.
f. Changes made following Architect/Engineer's written orders.
g. Details not on the original Contract Drawings.
h. Field records for variable and concealed conditions.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, Bulletin numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Architect/Engineer .
e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.

B. Format: Submit record Specifications as paper copy.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.

B. Format: Submit record Product Data as paper copy.

1. Include record Product Data directory organized by Specification Section number and title.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as paper copy.

1. Include miscellaneous record submittals directory organized by Specification Section number and title.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect/Engineer's and College’s reference during normal working hours.

END OF SECTION 017839

SECTION 020100 – SUBSURFACE EXPLORATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Existing Subsurface Conditions: A subsurface investigation has been conducted at the project site to determine general subsurface conditions. A copy of the report is included in this section.

B. Related Sections:

1. Division 31 Section “Site Clearing” and "Earth Moving" for earthwork requirements.

1.3 DEFINITIONS

A. The College and Architect/Engineer are not responsible for interpretations or assumptions made by the Contractor based on the subsurface exploration data furnished. The data is made available for the Contractor’s convenience. Opinions expressed in the report are the interpretation of the geotechnical engineer based on analysis and tests conducted by the firm. Additional subsurface investigation may be made by the Contractor at no increase to the Contract Sum. Obtain written permission from the College before proceeding with subsurface investigation.

B. Subsurface Materials: Boring logs indicate the general character of subsurface material encountered only at the boring locations.

C. Groundwater: Groundwater levels for the project site are not known. Groundwater fluctuations may occur with variations in precipitation, surface run-off and existing utility leakage.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 311000

MONTGOMERY COUNTY DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING REPORT

GOLDENROD LANE EXTENSION
GERMANTOWN, MARYLAND

FOR

A. MORTON THOMAS & ASSOCIATES

MAY 20, 2011

May 20, 2011

Mr. Matthew Ernest, P.E.
A. Morton Thomas & Associates, Inc.
12750 Twinbrook Parkway
Rockville, Maryland 20852

ECS Job No.: 13-4436

Reference: Geotechnical Engineering Report for Montgomery County Department of Transportation, Goldenrod Lane Extension, Montgomery College, Germantown, Maryland.

Dear Mr. Ernest:

ECS Mid-Atlantic, LLC. (ECS) has completed the subsurface exploration, soil laboratory testing, and geotechnical engineering analyses for the proposed roadway extension. Borings were drilled along the proposed alignment of the Goldenrod Lane extension. Our report is intended to meet the requirements of the Montgomery County Department of Transportation (MCDOT). Borings were also drilled in the proposed stormwater management pond areas.

PROJECT OVERVIEW

Project Location and Proposed Construction

The proposed Goldenrod Lane extension is located southeast of the intersection of Germantown Road (MD 118) and Goldenrod Lane, adjacent to the Montgomery College Germantown campus grounds, in Germantown, Maryland. The Site Vicinity Map, included in the Appendix of this report, shows the approximate location of this project.

We understand that the project will consist of 2,500 linear feet of roadway extension to the existing Goldenrod Lane. The county road will extend southward from the end of the existing road, and then turn eastward toward Germantown East Local Park where it will intersect the proposed extension of Observation Drive. The proposed alignment is currently heavily wooded. Fills on the order of 20 feet, and cuts on the order of 10 to 15 feet will be necessary to reach proposed roadway grades. Also planned at the site are multiple stormwater management ponds and facilities. Bottom elevations for these facilities were not available at the time of this report. Site retaining walls may also be necessary.

Scope of Work

The conclusions and recommendations contained in this report are based on our field subsurface explorations, laboratory testing, and review of available geologic and/or geotechnical data. The subsurface exploration program performed under this contract by ECS was limited to soil test borings to obtain soil samples along the proposed roadway and within the proposed stormwater management areas. Laboratory tests were then performed on selected soil samples to identify the soils and to assist in determination of the suitability of the subgrade soils for support of the proposed roadway. We have also visited the site recently to conduct a site reconnaissance of current conditions.

EXPLORATION PROCEDURES

Subsurface Exploration Procedures

The soil borings were performed using an all-terrain vehicle (ATV) mounted auger drilling rig (CME 750), which utilized continuous flight, hollow stem augers to advance the boreholes. Drilling fluid was not used in this process.

Representative soil samples were obtained by means of the split-spoon sampling procedure in accordance with ASTM Specification D-1586. In this procedure, a 2-inch O.D., split-spoon sampler is driven into the soil a distance of 18 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through the last 12-inch interval is termed the Standard Penetration Test (SPT) value, or N value, and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of noncohesive soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod sampler assemblies.

A field log of the soils encountered in the borings was maintained by the drill crew. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample were then sealed and brought to our laboratory for further visual examination and laboratory testing.

Nine (9) soil test borings (ROAD-1 through ROAD-9) were performed on the site along the alignment of the proposed roadway. Four (4) soil test borings (SWM-1 through SWM-4) were preformed within the proposed stormwater management areas. A copy of the boring logs is included in the Appendix.

Representative soil samples were obtained from the roadway soil borings in order to perform the required soil laboratory testing. Soil borings were drilled along the proposed roadway as follows:

Boring	Ground Surface Elevation (ft.)	Proposed Elevation at Centerline (ft.)	Cut/Fill (-/+)	Boring Depth (ft.)
ROAD-1	562.19	562.00	-0.19	19.9
ROAD-2	546.95	551.74	4.79	20.0
ROAD-3	531.54	543.73	12.19	20.0
ROAD-4	532.39	543.71	11.32	19.4
ROAD-5	555.59	551.48	-4.11	21.0
ROAD-6	568.64	558.00	-10.64	28.0
ROAD-7	555.00	552.14	-2.86	23.0
ROAD-8	532.89	534.38	-1.49	12.0
ROAD-9	503.23	509.49	6.26	20.0

EXPLORATION RESULTS

Laboratory Testing Program

Representative soil samples were selected and tested in our laboratory to confirm the field classifications and to determine pertinent engineering properties for evaluating the suitability of the on-site soils for support of pavements. The laboratory testing program included moisture content tests, Atterberg Limits, washed sieve gradation tests, standard proctor tests, and California Bearing Ratios (CBR). Data obtained from the laboratory tests are included in the Appendix, and are summarized in the table below and are included in the Appendix:

Boring No. (Depth)	Soil Description	Liquid Limit	Plasticity Index	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	CBR 1 Value (0.1"/0.2")	CBR 2 Value (0.1"/0.2")	Acceptable Subgrade Material Within 12" of Pavements
ROAD-1 (2'-10')	SILT w/ Sand (A-7-5)	44	16	105.8	18.0	0.7/1.2	0.7/1.3	NO
ROAD-5 (5'-10')	Sandy SILT (A-6)	38	12	121.0	13.7	6.6/8.4	4.4/7.9	YES
ROAD-6 (11'-15')	Sandy SILT (A-6)	36	11	121.4	12.6	3.6/6.0	4.5/10.2	YES
ROAD-7 (3'-10')	SILT w/ Sand (A-7-5)	41	13	104.4	18.4	1.0/1.4	0.5/0.9	NO
ROAD-8 (2'-10')	SILT w/ Sand (A-7-5)	44	15	109.5	15.1	2.3/3.3	3.1/4.8	NO

Current Site Conditions

A site visit was conducted by an engineer from ECS to observe existing site conditions. The site is undeveloped property that is currently heavily wooded. Existing grades in the area of the proposed roadway vary from about EL 503 and EL 564.

Regional Geology

The project site is located in the Piedmont Physiographic Province, an area underlain by ancient igneous and metamorphic rock. The virgin soils encountered in this area are the residual product of in-place chemical weathering of the parent rock presently underlying the site. The typical residual soil profile consists of silty to clayey soils near the surface where solid weathering is more advanced, underlain by more sandy silts and silty sands that generally become harder and denser with depth to the top of parent bedrock. The boundary between soil and rock, termed weathered or decomposed rock, is not sharply defined. This transitional zone can contain boulders of more resistant rock as well as highly weathered materials. Materials labeled as "Weathered Rock" on the boring logs exhibit the remnant structure of the underlying parent bedrock. Variable weathering is not uncommon in this area and should be expected.

According to the Geologic Map of Maryland (1968), the project site appears to be underlain by western piedmont metasedimentary rock of the Marburg Schist Formation. The Marburg Schist

Formation is characterized as bluish-gray to silver-green, fine-grained, muscovite-chlorite-albite-quartz-schist, intensely cleaved and closely folded, and contains interbedded quartzite.

Subsurface Conditions

Soil borings ROAD-1 to ROAD-9 were drilled within the proposed roadway to depths of 12 to 28 feet below the existing ground surface. Soil borings SWM-1 to SWM-4 were drilled within the proposed stormwater management areas to a depth of 20 feet below the existing ground surface. The approximate boring locations are presented on the enclosed Boring Location Diagram.

In general, the subsurface conditions encountered during the field exploration consisted of a topsoil layer (about 4 to 8 inches) overlying natural residual soils. A brief description of the soils encountered is presented in the following paragraphs. More detailed descriptions are provided on the boring logs in the Appendix.

Natural residual soils were encountered below the topsoil in the borings. The natural residual soils were encountered to depths of 12 to greater than 28 feet in the soil borings and generally consisted of SILT (ML) and Sandy SILT (ML) with varying amounts of clay, weathered rock, and rock fragments. Measured SPT values in the test borings ranged from 4 to 53 blows per foot (bpf) indicating loose to dense soils. The color of these residual materials ranged from brown to reddish borwn and the moisture contents in these soils were generally characterized as moist. It should be noted that the soil laboratory testing indicates that the on-site soils generally classify as SILT (A-7-5) and Sandy SILT (A-6).

Below and interbedded with the residual soils in borings ROAD-1, ROAD-3 through ROAD-6, ROAD-8, and SWM-2, extremely dense materials with a blow count greater than 60 has been noted on the boring log as weathered rock. The decomposed rock was encountered at depths of 6.0 to 18.5 feet, or EL 493 to EL 560. These materials exhibit rock like qualities and depending on various perimeters may be extremely difficult to excavate, and may require rock excavation methods for removal. The residual materials were generally observed to increase in density with depth across the project site.

Ground Water Observations

Ground water was not encountered in the roadway borings to the depths the borings caved (8.9 to 19.9 feet). Considering the depth of excavation required to achieve roadway subgrade, the ground water table is not expected to be a significant factor during design and construction. Ground water was encountered in boring SWM-3 at a depth of 18.0 feet, or EL 485.5. The remainder of the stormwater management borings were observed to be dry.

Variations in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, and other factors not immediately apparent at the time of this exploration. Groundwater may also be present as a perched condition and may be encountered at the interface of natural soils and decomposed rock or rock.

Infiltration Test Results

Infiltration testing was performed in offset borings next to borings SWM-1 through SWM-4 on March 30, 2011. The in-situ infiltration testing consisted of auguring a soil probe down to the test depth and installing a length of 4 inch diameter PVC pipe. The test hole was then

presoaked for 24 hours by filling the pipe with approximately 2 feet of water. After the initial filling of the pipe, infiltration testing was completed by monitoring the drop in the water level at 60-minute intervals for four hours. The rate of drop over the 4 total hours is considered the infiltration rate. The following table indicates the location, depth, material encountered, and infiltration rate at each test location.

Boring	Test Depth/Elevation (feet)	Material Encountered at Test Depth	Field Infiltration Rate (inches/hour)
SWM-1	10.0/510.31	Dense SILT (ML)	0.24
SWM-2	9.0/504.45	Dense SILT (ML)	0.15
SWM-3	9.0/494.29	Medium Dense SILT (ML)	0.48
SWM-4	10.0/482.07	Medium Dense SILT (ML)	0.51

Based upon results of the infiltration testing, stormwater management utilizing infiltration does not seem feasible at the depths tested.

It is recommended that a design infiltration rate consisting of 2/3 of the field rate be utilized, as siltation tends to decrease the allowable infiltration rate over time.

ANALYSES AND RECOMMENDATIONS

The recommendations presented in this report are based on the project information provided to us, the results of the soil test borings, laboratory testing, and the engineering analyses.

Pavement Subgrade Materials

According to the Montgomery County Department of Transportation Specifications for subdivision streets, the top 12 inches of subgrade material in cuts and fills shall have a liquid limit not to exceed 40, plasticity index not to exceed 12, and a maximum dry density of at least 105 pcf per AASHTO T-99 Method C. Soil test borings and laboratory testing indicate that silt and sandy silt soils may be expected at pavement subgrades. Based upon the soil laboratory test results, the soils tested in borings ROAD-5 from 5 feet to 10 feet and ROAD-6 from 11 feet to 15 feet generally meet the requirements for the upper 12 inches below pavement subgrades. However, the material tested in borings ROAD-1 from 2 feet to 10 feet, ROAD-7 from 3 feet to 10 feet, and ROAD-8 from 2 feet to 10 feet had liquid limits between 41 and 44 and plasticity index between 13 and 16, which is slightly higher than the allowable values of 40 and 12. Based on the soil laboratory testing, most of the on site soils are expected to be suitable for pavement subgrade support.

Fill and Pavement Subgrades

Prior to fill placement, the subgrade soils should be carefully examined by an experienced Geotechnical Engineer or authorized representative to identify any localized loose, yielding or otherwise unsuitable materials. After examining the exposed soils, loose and yielding areas should be identified by proofrolling with an approved piece of equipment, such as a loaded dump truck, having an axle weight of at least 10 tons. Any soft or unsuitable materials encountered during this proofrolling should be removed and replaced with an approved engineered fill compacted, or recompacted, to the criteria provided below**.**

Upon achieving competent subgrade materials, after the removal of the topsoil and any unsuitable soils, compacted structural fill should be placed to subgrade levels with an approved, controlled, compacted engineered fill. Engineered fill below the top 12 inches of subgrade level should consist of soils classified ML, SM, or more granular per ASTM D-2487, with a liquid limit and plasticity index of less than 40 and 15, respectively, and compacted to at least 95 percent of the maximum dry density per AASHTO T99 Method C. Fill in the top 12 inches below roadway subgrade levels should be classified as ML or more granular with a liquid limit and plasticity index of less than 40 and 12, respectively, and a maximum dry density of at least 105 pcf. The top 12 inches shall be compacted to at least 100 percent of the maximum dry density per AASHTO T99 Method C. All structural fill should be placed in loose lifts, which do not exceed 8 inches in thickness. Generally, the moisture content of the fill materials should be maintained within ±2 percent of the optimum moisture content for the fill material, as determined by AASHTO T-99.

An examination of the soil boring data and the lab testing results indicates that most of the on site silt and sandy silt soils will be suitable for reuse as controlled, compacted fill, below the top 12 inches of pavements. Prior to the utilization of any off-site borrow materials, the Geotechnical Engineer should be provided with representative samples in order to determine the material suitability for use as a controlled, compacted fill and to develop moisture-density relationships. In order to expedite the earthwork operations, if off-site borrow materials are required, it is recommended that those material consist of a granular material which will provide suitable support, and be easily compacted and well drained.

Grade controls should be maintained throughout the filling operations. All filling operations should be observed on a full-time basis by a qualified soils technician to determine that minimum compaction requirements are being achieved. A minimum of one compaction test per 2,500 square foot area should be made for each lift. The elevation and location of the tests should be clearly identified at the time of fill placement.

Compaction equipment suitable to the soil type used as fill should be selected to compact the fill. Theoretically, any equipment type can be used as long as the required density is achieved. Ideally, a steel drum roller would be most efficient for compacting and sealing the surface soils. However, for fine-grained soils a sheepsfoot roller is recommended. All areas receiving fill should be graded to facilitate positive drainage away from the roadways of any free water associated with precipitation and surface run-off.

Fill materials should not be placed on frozen soils or frost-heaved soils and/or soils which have been recently subjected to precipitation. All frozen soils should be removed prior to continuation of fill operations. Borrow fill materials, if required, should not contain frozen materials at the time of placement.

If any problems are encountered during the earthwork operations, or if site conditions deviate from those encountered during our subsurface exploration, the Geotechnical Engineer should be notified immediately.

Stormwater Management Ponds

New stormwater management ponds will be constructed at the site. Proposed bottom elevations of the ponds were not available at the time of this report. The pond borings indicate firm to very dense SILT (ML) soils in the areas of the new ponds.

The soils encountered are considered suitable for support of new embankment fill, however, the actual suitability should be evaluated by the Geotechnical Engineer or his representative during construction.

Below Grade Walls

Below grade walls should be designed to withstand lateral earth pressures at at-rest conditions and any surcharge loads within a 45 degree slope from the base of the wall. We recommend that the below grade walls be designed for a linearly increasing lateral earth pressure of 60 psf per vertical foot of wall. This lateral earth pressure diagrams does not include hydrostatic pressure and assumes full drainage and a subdrainage system should be installed behind the walls. In addition exterior grades should be properly sloped to allow drainage of surface runoff away from the building. We recommend a minimum slope of 5% away from the structures. Surcharge loading within a 45 degree slope from the bottom of the wall should be applied with a combined active and at rest pressure coefficient of 0.4. In order to maintain a 60 psf lateral earth pressure, drainage of the backfill of the proposed building must be provided. A lateral earth pressure earth pressure diagram is included in the Appendix at the end of this report.

A lateral passive earth pressure of 350 psf per foot of soil may be used for design. The passive resistance should be neglected to a depth of 2.5 feet in areas exposed to freezing conditions and in areas where there is a possibility that the soil in front of the wall will become disturbed or be excavated at any time in the future. Considering the relatively fine-grained soils, which may constitute the wall foundation bearing subgrade, a friction factor of 0.45 is recommended for sliding resistance analysis.

To achieve a desirable balance between minimizing excessive pressures against the below grade walls and reducing the settlement of the wall backfill, we recommend that the wall granular backfill be compacted to 95% of the maximum dry density obtained in accordance with ASTM Specification D-698, Standard Proctor Method.

Backfill materials should consist of inorganic materials classified SM, SC or more granular per ASTM D-2487 that are free of debris. The fill placed adjacent to the below grade walls should not be over compacted. Heavy earthwork equipment should maintain a minimum horizontal distance away from the below grade walls of 1 foot per foot of vertical wall height. Lighter compaction equipment should be used close to the below grade walls.

Retaining Walls

Retaining walls, which are free to rotate at the top and mobilize more of the shear strength of the soil, can be designed for an active lateral pressure of 40 psf per foot of wall height, where the backgrades are horizontal. Retaining walls with angular joints or corners that limit the free rotation of the stem should be designed for at-rest lateral earth pressures of 60 psf. Where the wall backgrades are sloping the wall design should consider the surcharge effect of the extra earth retained. For resistance purposes, passive lateral pressures at the face of the footing can be 250 psf per foot of soil height. These values are based on cohesion value of zero, and a friction angle of 30°, which is typical of the soils observed. The frictional resistance factor against sliding should be considered as 0.45. These values are based on use of on-site material used as backfill. If select granular material is used, they may be adjusted accordingly.

If the wall is constructed on fill material placed in accordance with our recommendations in “Fill Placement”, the passive resistance shall be decreased to 200 psf per foot of depth, and a

frictional resistance coefficient of 0.40 can be utilized for the sliding resistance in the design. If utility lines will be constructed in front of the wall, the retaining wall footing should be stepped-down to invert elevations of the deepest pipe, and the passive resistance of the soil above the invert level should be neglected.

Retaining walls should also account for surcharge loads within a 45° slope from the base of the backside of the wall. In addition, the design pressure outlined above should be modified if a sloping backfill is required. The passive resistance should be neglected in the stability calculations if there is a possibility that the soil in front of the wall footing will be excavated at any time in the future and reduced if the wall is sited on a significant foreslope. Retaining walls should have a minimum factor of safety of 1.5 or greater against sliding and overturning. The values given above have not been corrected for that safety factor. Their final design should be performed by a qualified geotechnical engineer. ECS can provide the design for these walls if requested.

The recommendations contained above assume that backfill with Silty SAND (SM) or more granular soils are used, and that the backfill behind the retaining wall is properly drained. Drainage of the backfill may be accomplished through the use of 3-inch diameter weep holes at 10 feet spacing, through the wall, immediately above the proposed grade in front of the wall. Alternatively, a longitudinal drain line may be placed behind the retaining wall, sloped to discharge by gravity. The drain should consist of a 6 inch perforated pipe surrounded by a minimum of 6 inches of AASHTO #57 stone. The #57 stone should be completely wrapped in a filtration geotextile such as Mirafi 140N with an AOS of 70. The geotextile used should be reviewed and approved by the geotechnical engineer.

Mechanically stabilized earth retaining walls are also a viable alternative. Should these be used, all of the above recommendations will apply along with the following factors of safety: Grid pullout, 1.5; Grid connection, 1.5; Global stability, 1.5.

The footings for the retaining walls can be designed for 3,000 psf bearing, provided that they are supported on suitable natural soils (N-value greater than 9 bpf) or on newly placed and compacted engineered soil fill.

Closing

This report has been prepared to aid in the design and construction of the proposed roadway and stormwater management ponds. The report scope is limited to this specific project and the location described. The project description represents our current understanding of the significant aspects of the proposed improvements relevant to the geotechnical considerations.

We have appreciated the opportunity to be of service to A. Morton Thomas & Associates and hope to continue our involvement on the project during the construction phases. ECS is capable of providing all construction materials testing services for the project, and we would appreciate the opportunity to offer our services.

If you have any questions regarding the information and recommendations contained in the accompanying report, or if we may be of further assistance to you in any way during planning or construction of this project, please contact us.

Respectfully,
ECS Mid-Atlantic, LLC

Gregory A. Ratkowski
Project Engineer

Jeffrey A. McGregor, P.E.
Geotechnical Manager

I:\Department 3 Geotechnical\GEOTECHNICAL\PROJECTS\4400's\13-4436 Goldenrod Lane Extension\13-4436 Goldenrod Lane MCDOT and SWM Report.doc

APPENDIX

Site Vicinity Map

Unified Soil Classification System

Laboratory Data

Reference Notes for Boring Logs

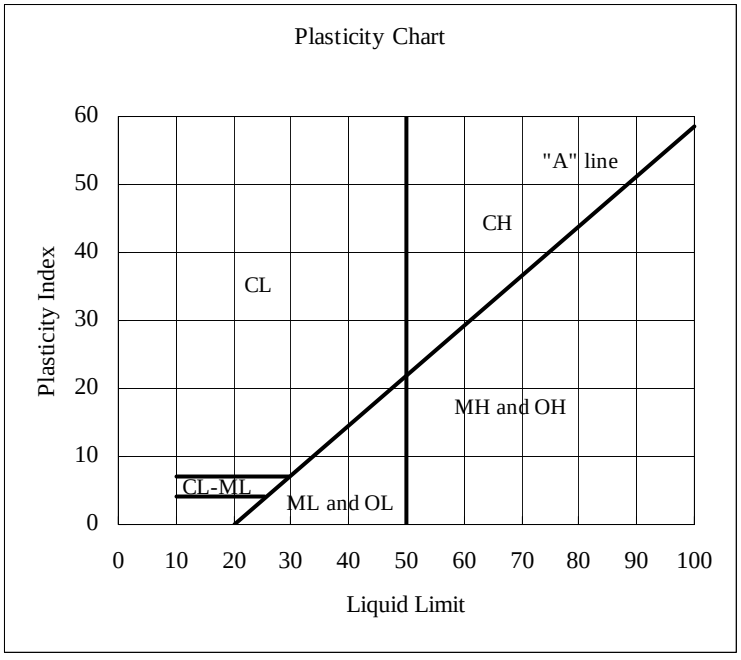
Boring Logs (ROAD-1 through ROAD-9, SWM-1 through SWM-4)

Boring Location Plan

ECS	SITE LOCATION DIAGRAM GOLDENROD LANE EXTENSION					
	A. MORTON THOMAS & ASSOCIATES					
	AMH	GAR	05-10-11	NTS	13-4436	1 OF 1

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols [b]	$C_u = D_{60}/D_{10}$ greater than 4 $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM [a]	d	Silty gravels, gravel-sand mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. less than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ greater than 6 $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM [a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 Sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt		Peat and other highly organic soils			



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC,well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)

ECS Mid-Atlantic, LLC
Frederick, MD
Laboratory Testing Summary

Printed on (date): May 12, 2011

Project No. 4436 **Project Name.** Goldenrod Lane Extension

Project Engineer Gregory A. Ratkowski **Principal Engineer** Jeffrey A. McGregor **Summary By** Gregory A. Ratkowski

Boring Number	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
ROAD-1	S-1	1.00 - 2.50	22.5	ML	44	28	16	75.0	105.8	18.0		
ROAD-1	S-2	3.50 - 5.00	14.5									
ROAD-1	S-3	6.00 - 7.50	17.3									
ROAD-5	S-1	1.00 - 2.50	12.6									
ROAD-5	S-2	3.50 - 5.00	9.7									
ROAD-5	S-3	6.00 - 7.50	8.3	ML	38	26	12	53.0	121.0	13.7		
ROAD-5	S-4	8.50 - 10.00	11.2									
ROAD-5	S-5	13.50 - 15.00	18.1									
ROAD-6	S-1	1.00 - 2.50	19.7									
ROAD-6	S-2	3.50 - 5.00	18.7									
ROAD-6	S-3	6.00 - 7.50	12.0									
ROAD-6	S-4	8.50 - 9.25	8.1									
ROAD-6	S-5	13.50 - 13.67	5.7	ML	36	25	11	55.0	121.4	12.6		
ROAD-6	S-6	18.50 - 18.92	7.5									
ROAD-7	S-1	1.00 - 2.50	22.5									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

ECS Mid-Atlantic, LLC
Frederick, MD
Laboratory Testing Summary

Printed on (date): May 12, 2011

Project No. 4436 **Project Name.** Goldenrod Lane Extension

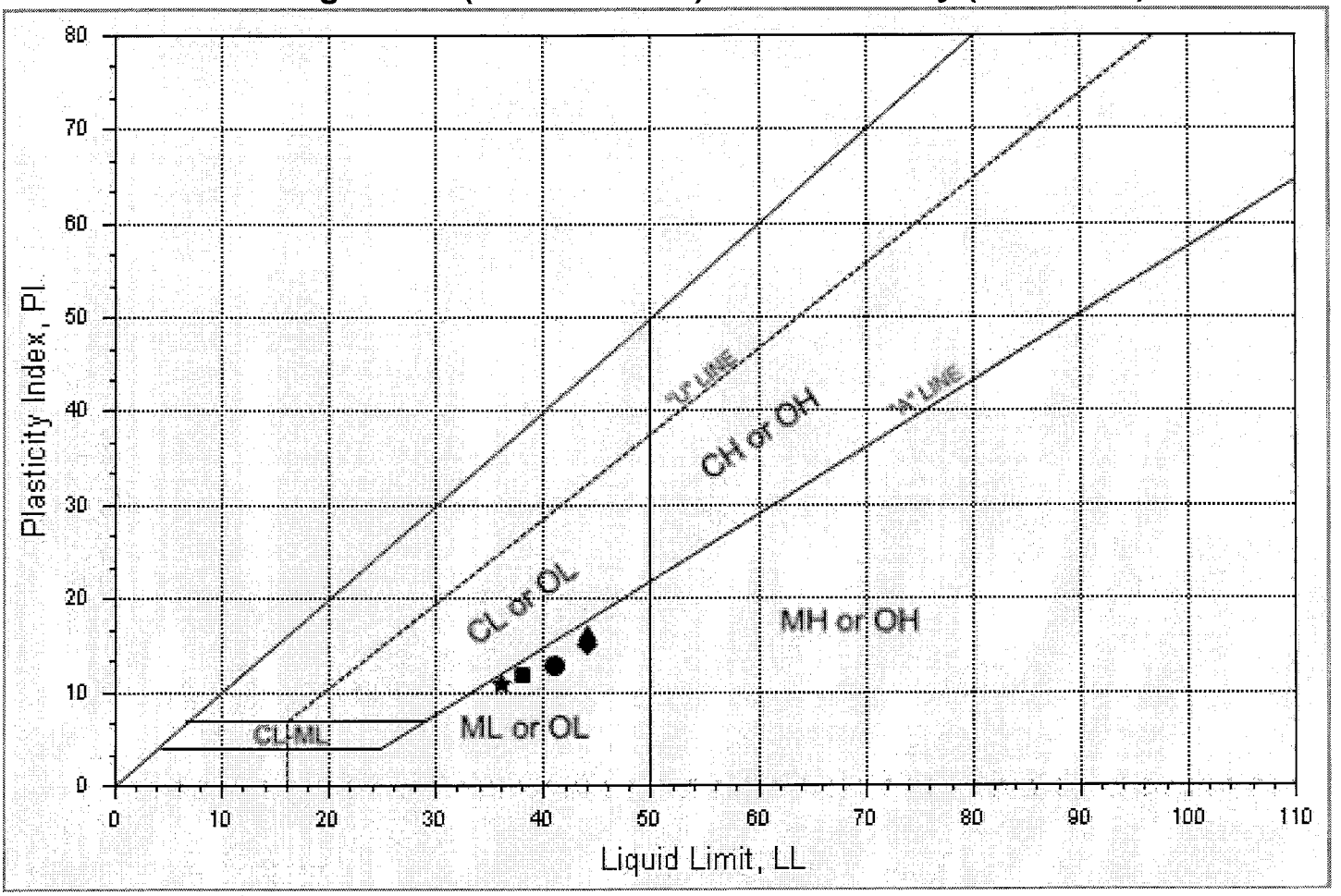
Project Engineer Gregory A. Ratkowski **Principal Engineer** Jeffrey A. McGregor **Summary By** Gregory A. Ratkowski

Boring Number	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
ROAD-7	S-2	3.50 - 5.00	19.6									
ROAD-7	S-3	6.00 - 7.50	19.2	ML	41	28	13	70.0	104.4	18.4		
ROAD-7	S-4	8.50 - 10.00	12.5									
ROAD-7	S-5	13.50 - 15.00	12.7									
ROAD-8	S-1	1.00 - 2.50	23.0									
ROAD-8	S-2	3.50 - 5.00	22.9	ML	44	29	15	71.0	109.5	15.1		
ROAD-8	S-3	6.00 - 7.50	10.9									
ROAD-8	S-4	8.50 - 10.00	4.1									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Atterberg Limits (ASTM D 4318) Test Summary (Method A)



All samples are prepared using 'DRY' method unless otherwise noted

Boring Number Sample Number	Depth (feet)	Test Symbol	Description	MC (%)	LL	PL	PI	% Passing #200 Sieve	% Sample Retained on #40 Sieve	Notes
ROAD-1 / S-1	1.00 - 2.50	▲	REDDISH BROWN SILT W/SAND	22.5	44	28	16	75.0	13.0	
ROAD-5 / S-3	6.00 - 7.50	■	REDDISH BROWN SANDY SILT	8.3	38	26	12	53.0	35.0	
ROAD-6 / S-5	13.50 - 13.67	★	REDDISH BROWN SANDY SILT	5.7	36	25	11	55.0	32.0	
ROAD-7 / S-3	6.00 - 7.50	●	REDDISH BROWN SILT W/SAND	19.2	41	28	13	70.0	14.0	
ROAD-8 / S-2	3.50 - 5.00	◆	REDDISH BROWN SILT W/SAND	22.9	44	29	15	71.0	18.0	

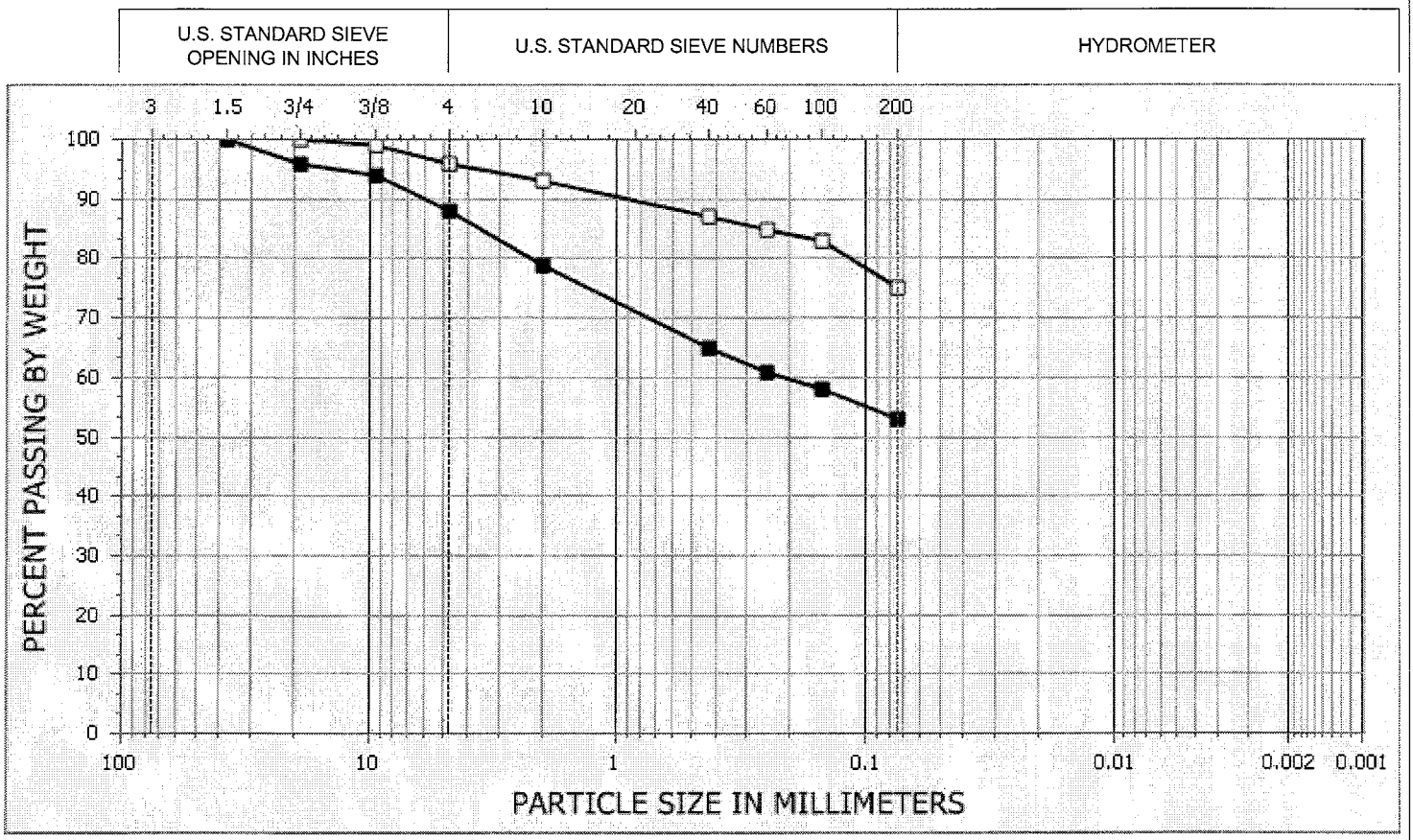
Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 12, 2011

ECS Mid-Atlantic, LLC

Frederick, MD

Grain Size (ASTM D 422) Test Summary

COBBLES	GRAVEL		SAND			SILT OR CLAY	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY



Boring Number Sample Number	Depth (feet)	Test Symbol	LL	PI	Description
ROAD-1 / S-1	1.00 - 2.50	□	44	16	REDDISH BROWN SILT W/SAND
ROAD-5 / S-3	6.00 - 7.50	■	38	12	REDDISH BROWN SANDY SILT

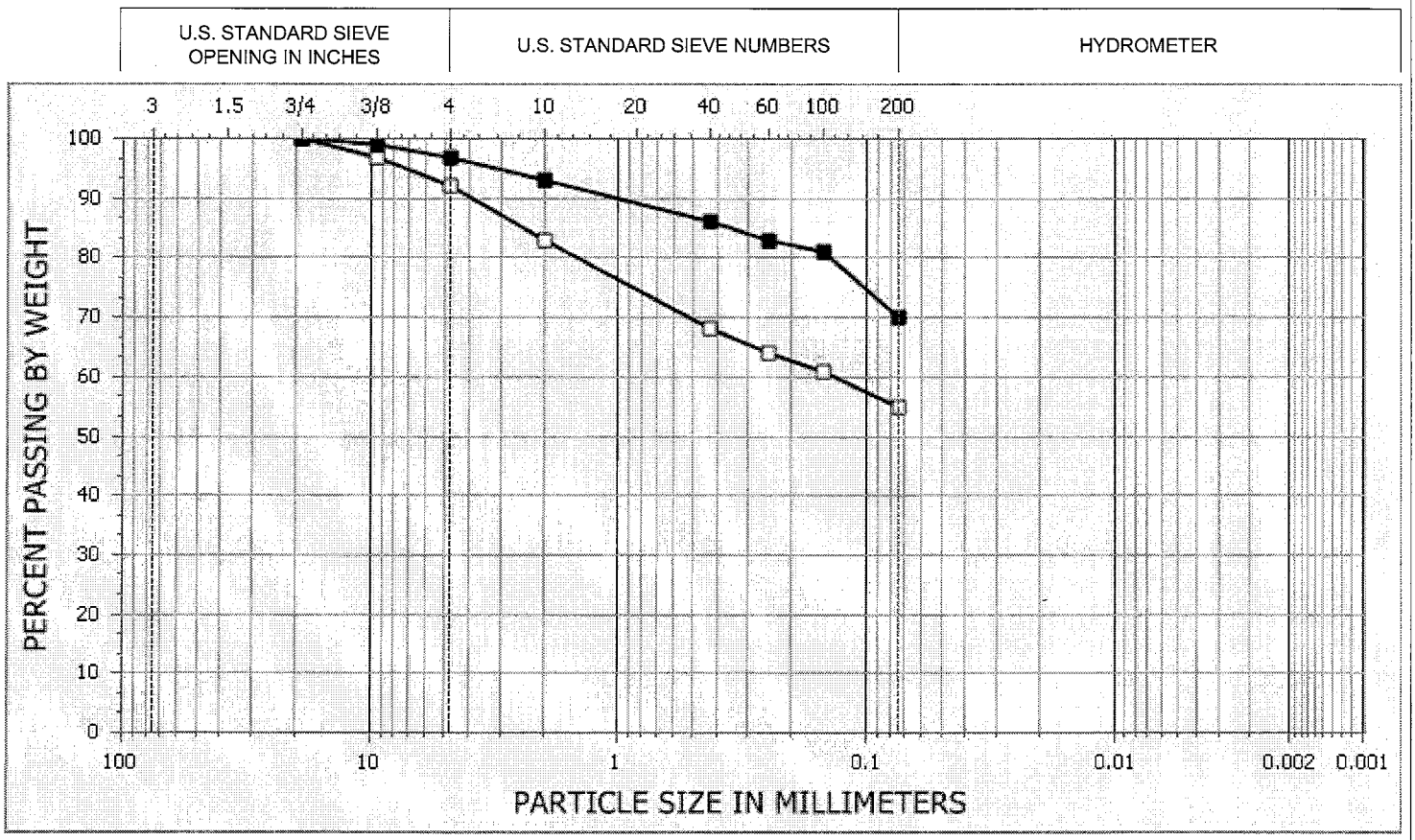
Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 12, 2011

ECS Mid-Atlantic, LLC

Frederick, MD

Grain Size (ASTM D 422) Test Summary

COBBLES	GRAVEL		SAND			SILT OR CLAY	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY



Boring Number Sample Number	Depth (feet)	Test Symbol	LL	PI	Description
ROAD-6 / S-5	13.50 - 13.67	□	36	11	REDDISH BROWN SANDY SILT
ROAD-7 / S-3	6.00 - 7.50	■	41	13	REDDISH BROWN SILT W/SAND

Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 12, 2011

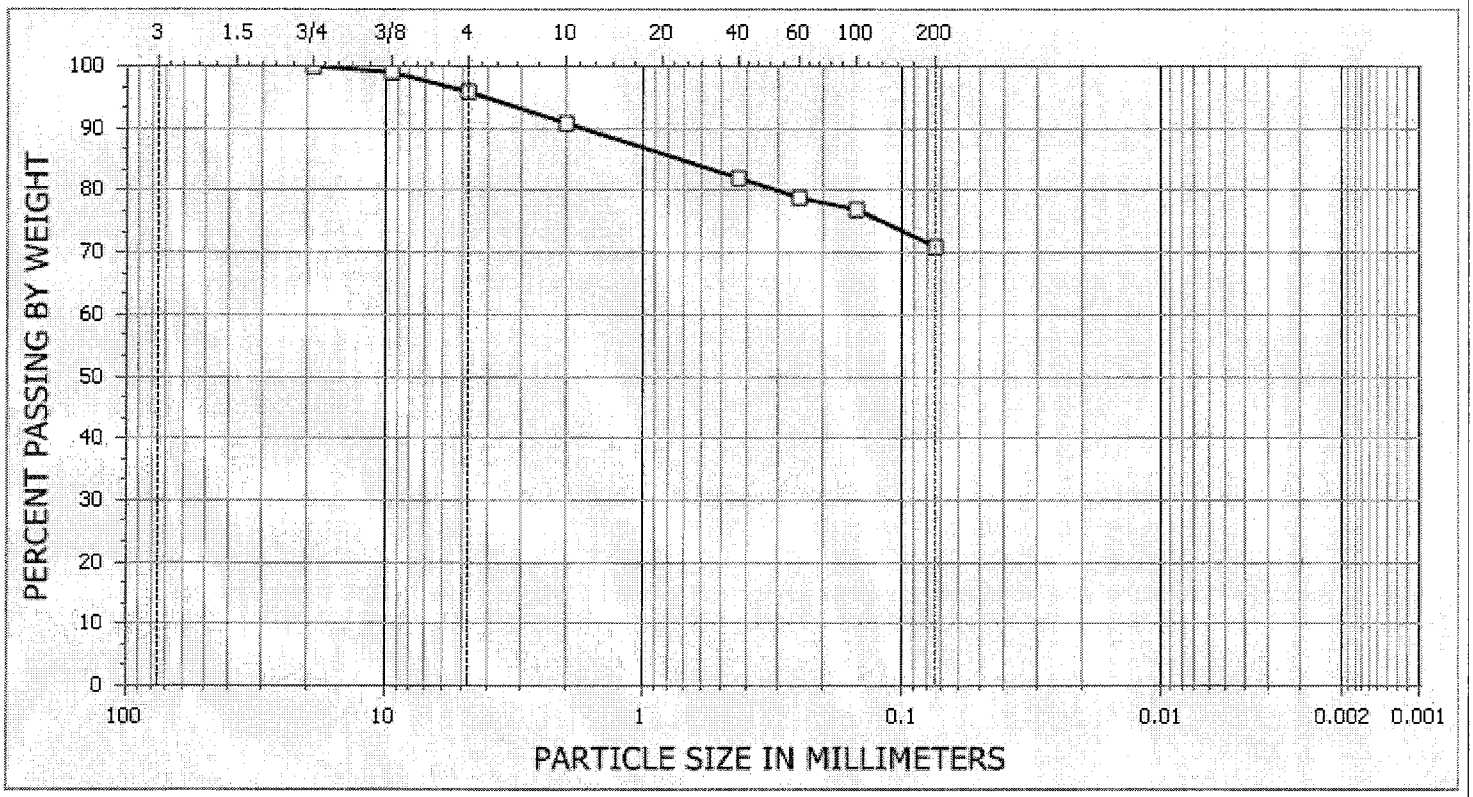
ECS Mid-Atlantic, LLC

Frederick, MD

Grain Size (ASTM D 422) Test Summary

COBBLES	GRAVEL		SAND			SILT OR CLAY	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY

U.S. STANDARD SIEVE OPENING IN INCHES	U.S. STANDARD SIEVE NUMBERS	HYDROMETER



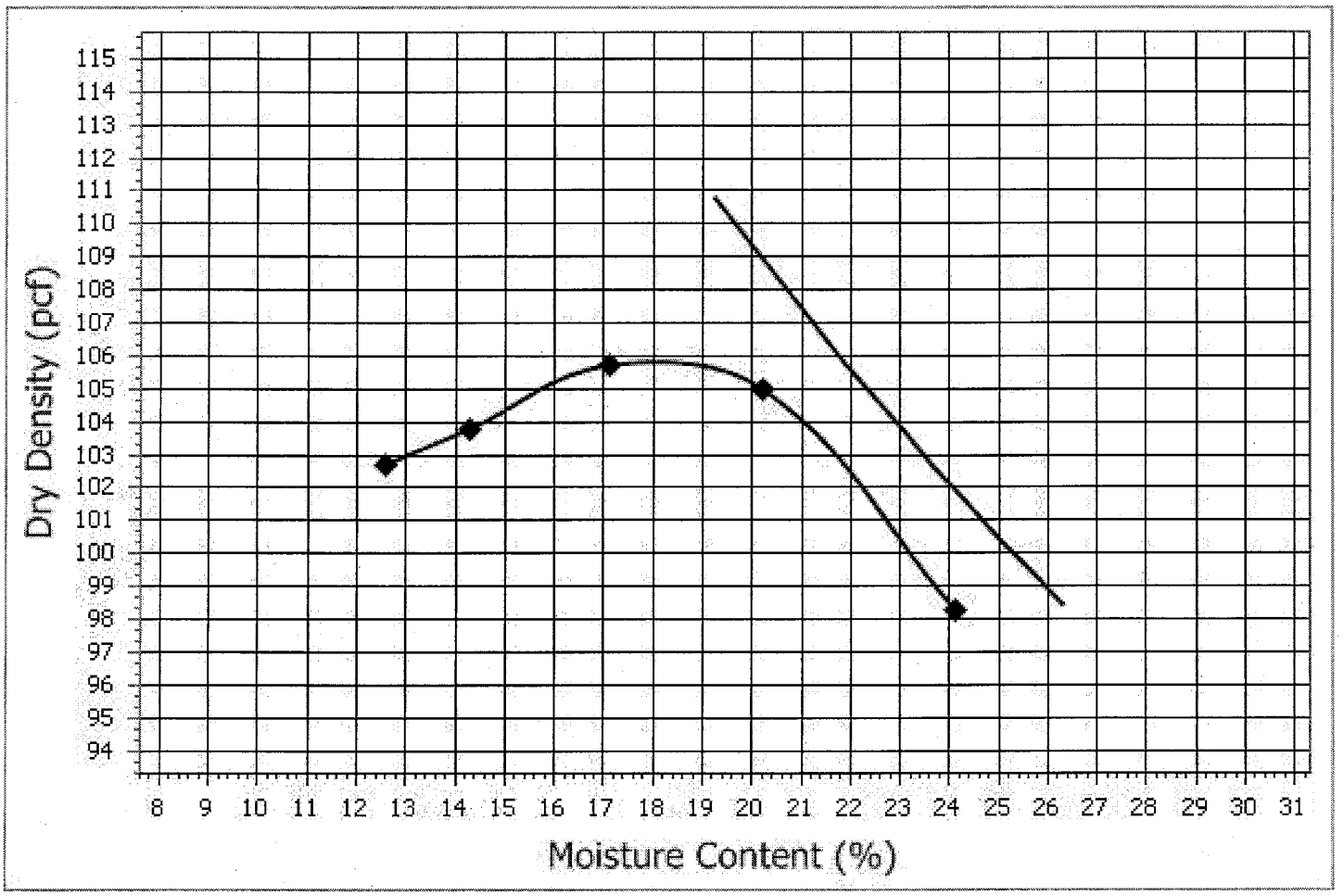
Boring Number Sample Number	Depth (feet)	Test Symbol	LL	PI	Description
ROAD-8 / S-2	3.50 - 5.00	☐	44	15	REDDISH BROWN SILT W/SAND

Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 12, 2011

ECS Mid-Atlantic, LLC

Frederick, MD

Proctor (ASTM D 698)Test Summary



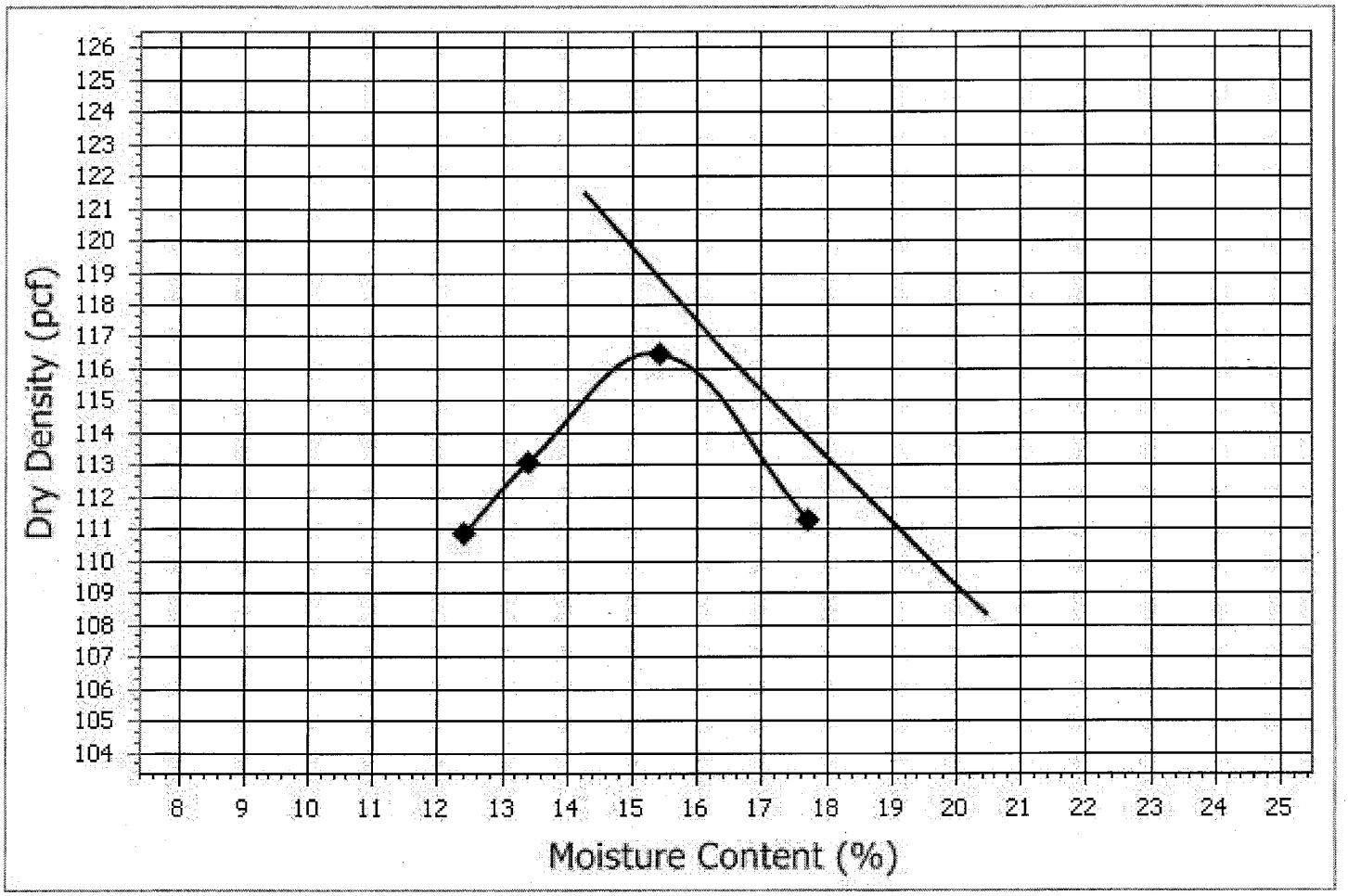
Liquid Limit (LL)	44	**Natural Moisture Content**	23
Plastic Limit (PL)	28	**Percent Passing No. 200 Sieve**	75.0
Plasticity Index (PI)	16	**Percent Retained on the No. 4 Sieve**	4
Liquidity Index (LI)	----	**Maximum Dry Density (pcf)**	105.8
Description	REDDISH BROWN SILT W/SAND	**Optimum Moisture Content (%)**	18.0
		Corr. Maximum Dry Density (pcf)	105.8
Classification	ML	**Corr. Optimum Moisture Content (%)**	18.0
Test Method	A	**Test Standard**	ASTM D 698
Specific Gravity of Soil	2.70	**Specific Gravity of Soil Determination Test Method**	Estimated
Specific Gravity of Oversize Fraction	2.70	**Specific Gravity of Oversize Fraction Test Method**	Estimated
Boring Number	ROAD-1	**Sample Number**	S-1
Preparation Method	Dry	**Rammer Type**	Manual

Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 06, 2011

ECS Mid-Atlantic, LLC

Frederick, MD

Proctor (ASTM D 698)Test Summary



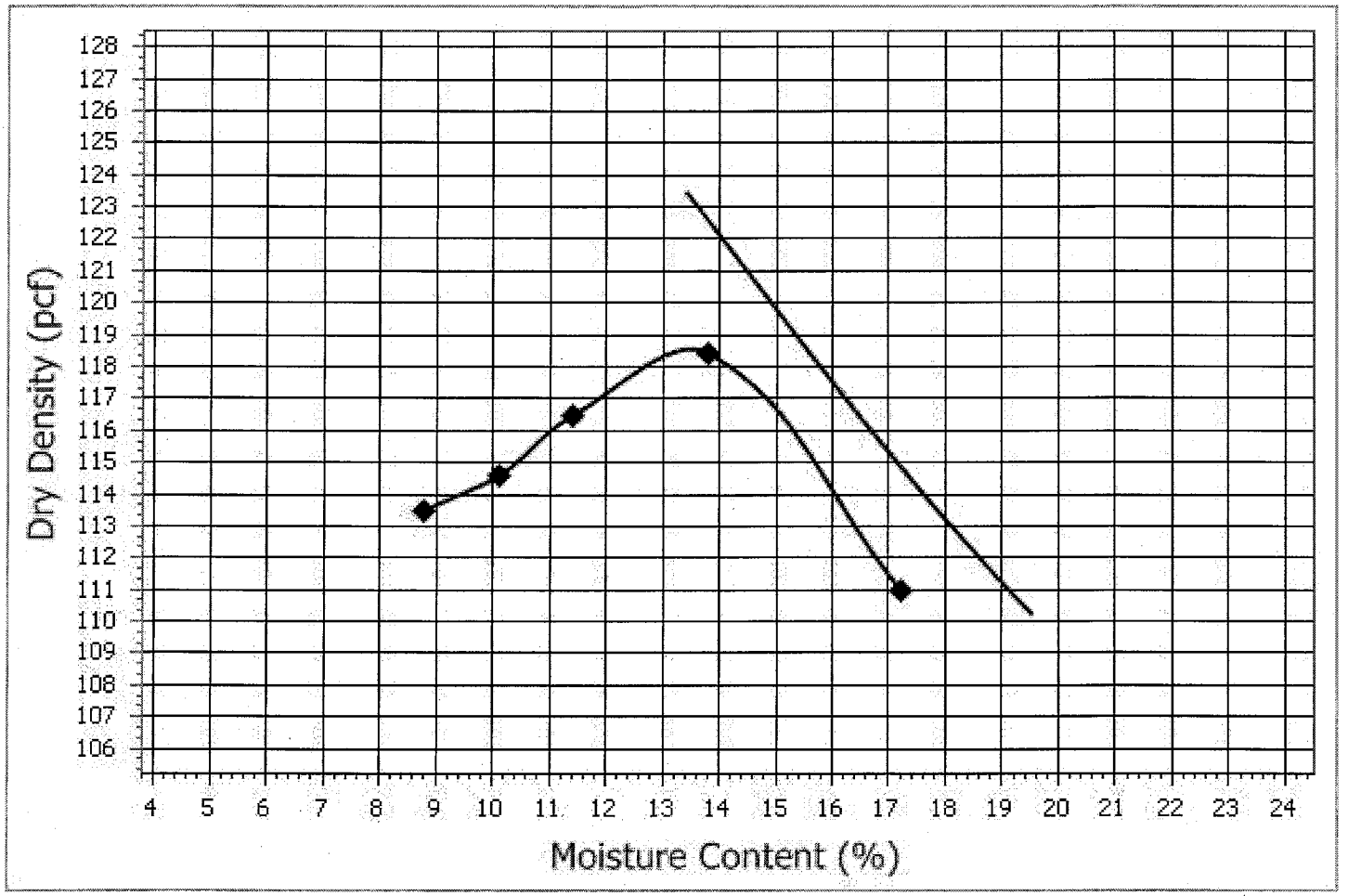
Liquid Limit (LL)	38	**Natural Moisture Content**	8
Plastic Limit (PL)	26	**Percent Passing No. 200 Sieve**	53.0
Plasticity Index (PI)	12	**Percent Retained on the No. 4 Sieve**	12
Liquidity Index (LI)	----	**Maximum Dry Density (pcf)**	116.5
Description	REDDISH BROWN SANDY SILT	**Optimum Moisture Content (%)**	15.3
		Corr. Maximum Dry Density (pcf)	121.0
Classification	ML	**Corr. Optimum Moisture Content (%)**	13.7
Test Method	A	**Test Standard**	ASTM D 698
Specific Gravity of Soil	2.70	**Specific Gravity of Soil Determination Test Method**	Estimated
Specific Gravity of Oversize Fraction	2.70	**Specific Gravity of Oversize Fraction Test Method**	Estimated
Boring Number	ROAD-5	**Sample Number**	S-3
Preparation Method	Dry	**Rammer Type**	Manual

Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 06, 2011

ECS Mid-Atlantic, LLC

Frederick, MD

Proctor (ASTM D 698)Test Summary



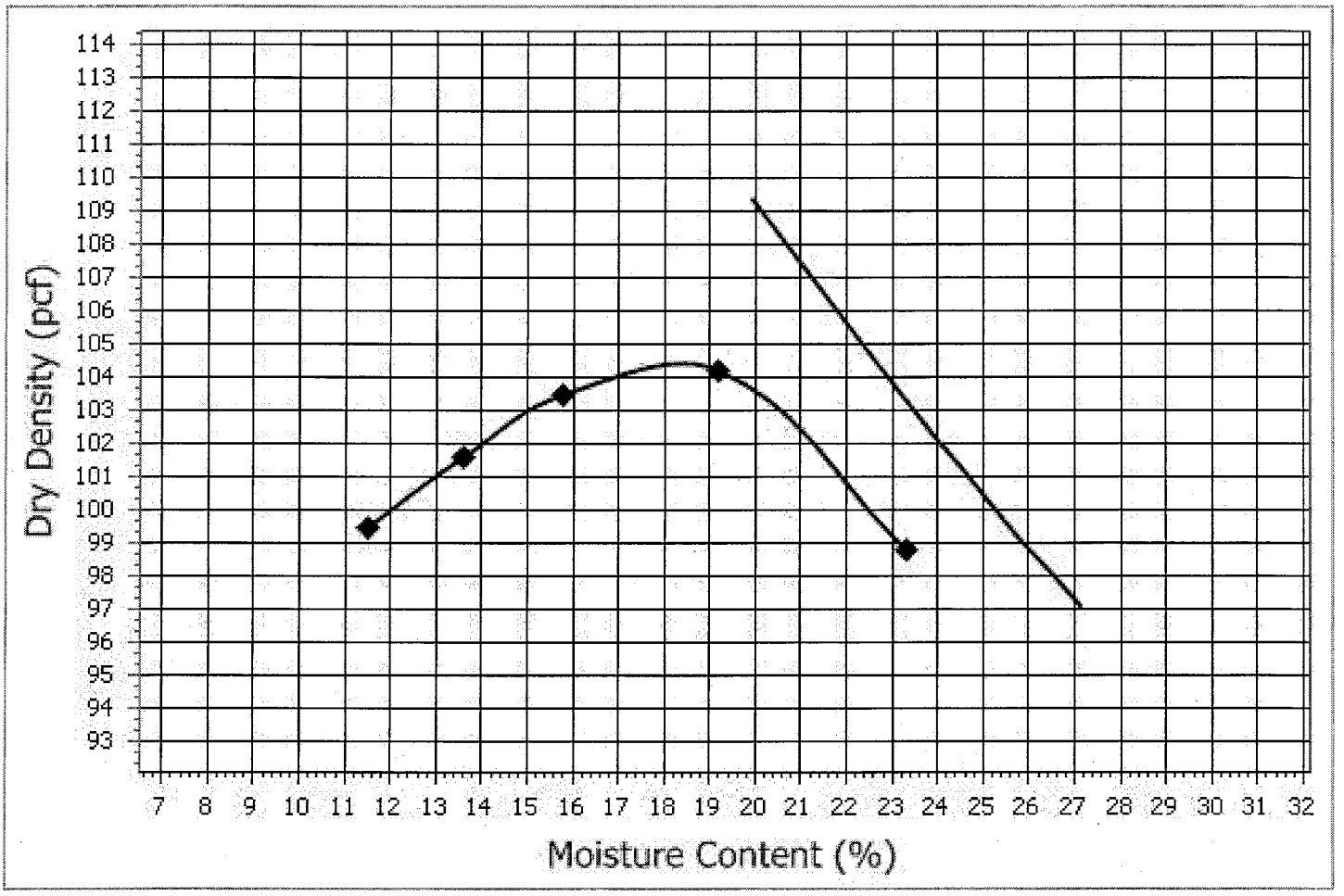
Liquid Limit (LL)	36	**Natural Moisture Content**	6
Plastic Limit (PL)	25	**Percent Passing No. 200 Sieve**	55.0
Plasticity Index (PI)	11	**Percent Retained on the No. 4 Sieve**	8
Liquidity Index (LI)	----	**Maximum Dry Density (pcf)**	118.5
Description	REDDISH BROWN SANDY SILT	**Optimum Moisture Content (%)**	13.5
		Corr. Maximum Dry Density (pcf)	121.4
Classification	ML	**Corr. Optimum Moisture Content (%)**	12.6
Test Method	A	**Test Standard**	ASTM D 698
Specific Gravity of Soil	2.70	**Specific Gravity of Soil Determination Test Method**	Estimated
Specific Gravity of Oversize Fraction	2.70	**Specific Gravity of Oversize Fraction Test Method**	Estimated
Boring Number	ROAD-6	**Sample Number**	S-5
Preparation Method	Dry	**Rammer Type**	Manual

Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 06, 2011

ECS Mid-Atlantic, LLC

Frederick, MD

Proctor (ASTM D 698)Test Summary



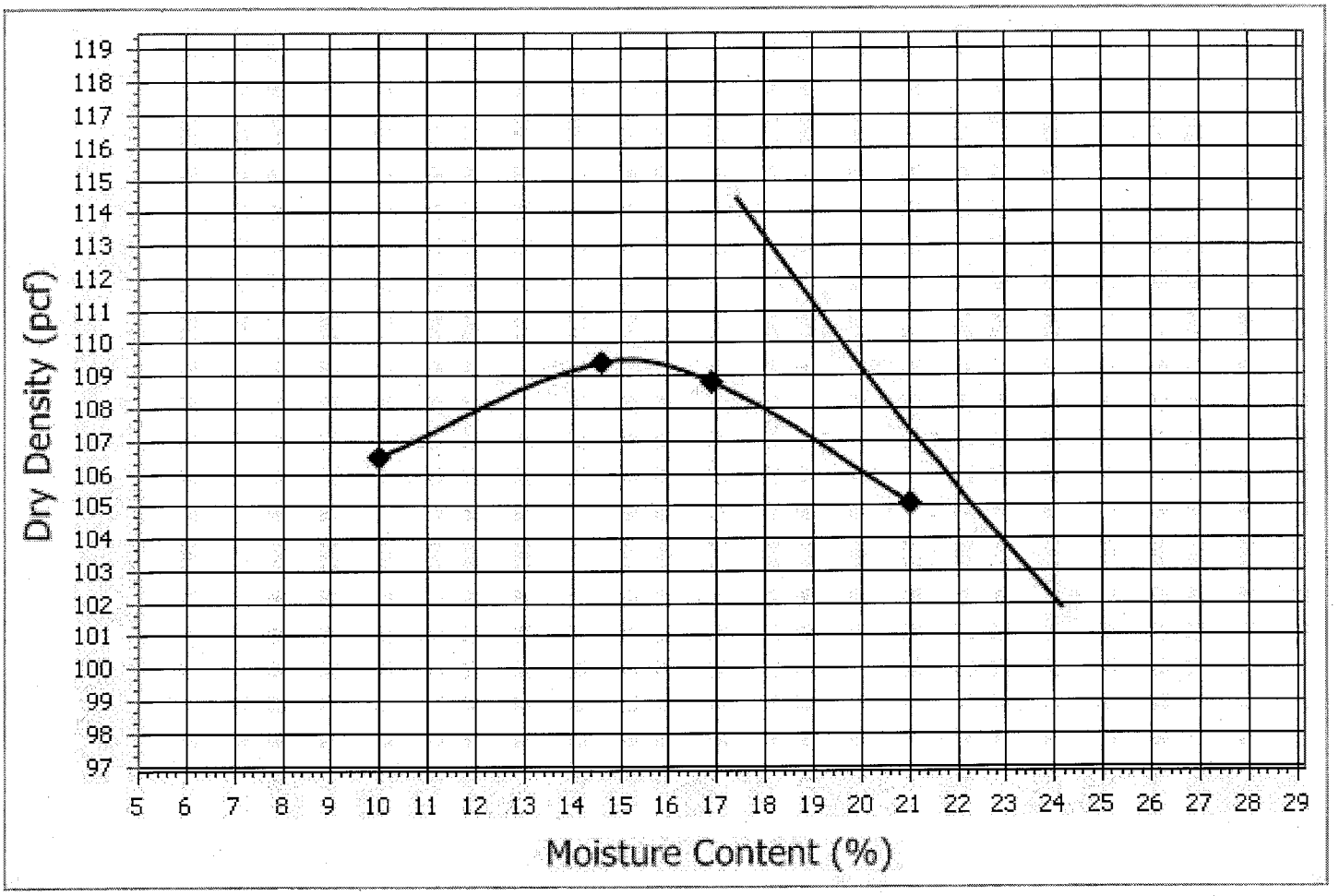
Liquid Limit (LL)	41	**Natural Moisture Content**	19
Plastic Limit (PL)	28	**Percent Passing No. 200 Sieve**	70.0
Plasticity Index (PI)	13	**Percent Retained on the No. 4 Sieve**	4
Liquidity Index (LI)	----	**Maximum Dry Density (pcf)**	104.4
Description	REDDISH BROWN SILT W/SAND	**Optimum Moisture Content (%)**	18.4
		Corr. Maximum Dry Density (pcf)	104.4
Classification	ML	**Corr. Optimum Moisture Content (%)**	18.4
Test Method	A	**Test Standard**	ASTM D 698
Specific Gravity of Soil	2.70	**Specific Gravity of Soil Determination Test Method**	Estimated
Specific Gravity of Oversize Fraction	2.70	**Specific Gravity of Oversize Fraction Test Method**	Estimated
Boring Number	ROAD-7	**Sample Number**	S-3
Preparation Method	Dry	**Rammer Type**	Manual

Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 06, 2011

ECS Mid-Atlantic, LLC

Frederick, MD

Proctor (ASTM D 698)Test Summary

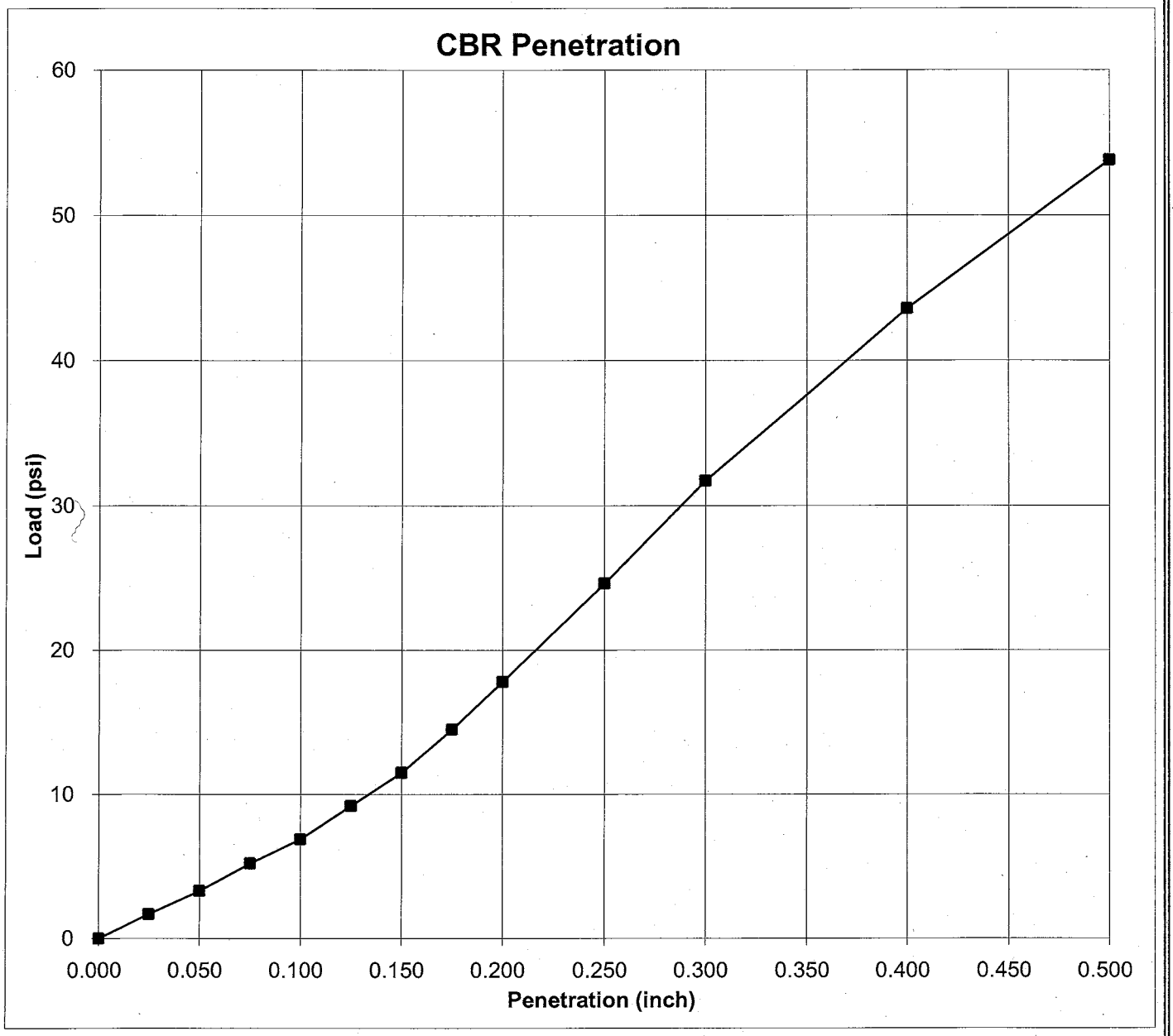


Liquid Limit (LL)	44	**Natural Moisture Content**	23
Plastic Limit (PL)	29	**Percent Passing No. 200 Sieve**	71.0
Plasticity Index (PI)	15	**Percent Retained on the No. 4 Sieve**	4
Liquidity Index (LI)	----	**Maximum Dry Density (pcf)**	109.5
Description	REDDISH BROWN SILT W/SAND	**Optimum Moisture Content (%)**	15.1
		Corr. Maximum Dry Density (pcf)	109.5
Classification	ML	**Corr. Optimum Moisture Content (%)**	15.1
Test Method	A	**Test Standard**	ASTM D 698
Specific Gravity of Soil	2.70	**Specific Gravity of Soil Determination Test Method**	Estimated
Specific Gravity of Oversize Fraction	2.70	**Specific Gravity of Oversize Fraction Test Method**	Estimated
Boring Number	ROAD-8	**Sample Number**	S-2
Preparation Method	Dry	**Rammer Type**	Manual

Project No.	4436
Project Name:	Goldenrod Lane Extension
PM:	Gregory A. Ratkowski
PE:	Jeffrey A. McGregor
Printed on(date):	May 06, 2011

ECS Mid-Atlantic, LLC

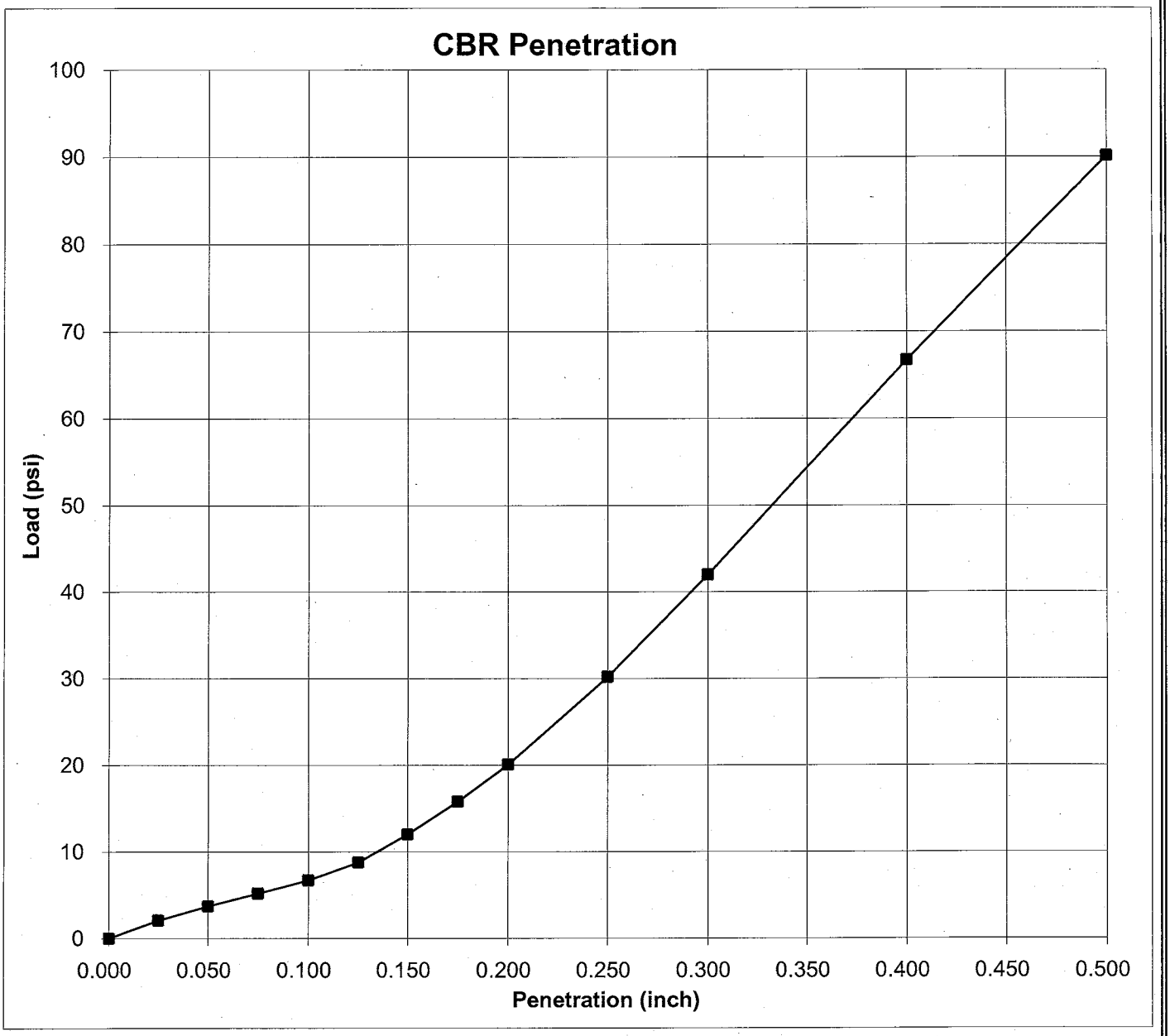
Frederick, MD



Sample No.: ROAD1-S1	Street: 0
Description: REDDISH BROWN SILT W/SAND	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	105.8		CBR 1
Opt. Moisture Content (%)	18.0	Corrected CBR @ 0.1"	0.7
Natural Moisture Content	22.5	Corrected CBR @ 0.2"	1.2
Liquid Limit (LL)	44	Proctor Method	D-698
Plastic Limit (PL)	28	Dry Density as Molded	99.3
Plasticity Index (PI)	16	Molded Moisture Content	20.2
Liquidity Index (LI)		Percent of Maximum Density	93.9
Percent Retained 3/4" Sieve		Moisture Content +/- Opt	2.2
Percent Retained No. 4 Sieve	3.6	Percent (%)Swell	4.3
Percent Passing No.200 Sieve	75.0		

Project: GOLDENROD LANE EXT.	**ECS MID-ATLANTIC, LLC**
Project No.: 4436	**Frederick, Maryland**
Date: 05/06/11	**California Bearing Ratio Curves**



Sample No.: ROAD1-S1	Street: 0
Description: REDDISH BROWN SILT W/SAND	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	105.8
Opt. Moisture Content (%)	18.0
Natural Moisture Content	22.5
Liquid Limit (LL)	44
Plastic Limit (PL)	28
Plasticity Index (PI)	16
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	
Percent Retained No. 4 Sieve	3.6
Percent Passing No.200 Sieve	75.0

	CBR 2
Corrected CBR @ 0.1"	0.7
Corrected CBR @ 0.2"	1.3
Proctor Method	D-698
Dry Density as Molded	104.5
Molded Moisture Content	20.2
Percent of Maximum Density	98.8
Moisture Content +/- Opt	2.2
Percent (%)Swell	4.9

Project: GOLDENROD LANE EXT.
Project No.: 4436
Date: 05/06/11

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

Engineering Consulting Services, Ltd.
Frederick, Maryland

California Bearing Ratio
ASTM D-1883

Date: 6-May-11

Project Name: GOLDENROD LANE EXT.
Project Number: 4436

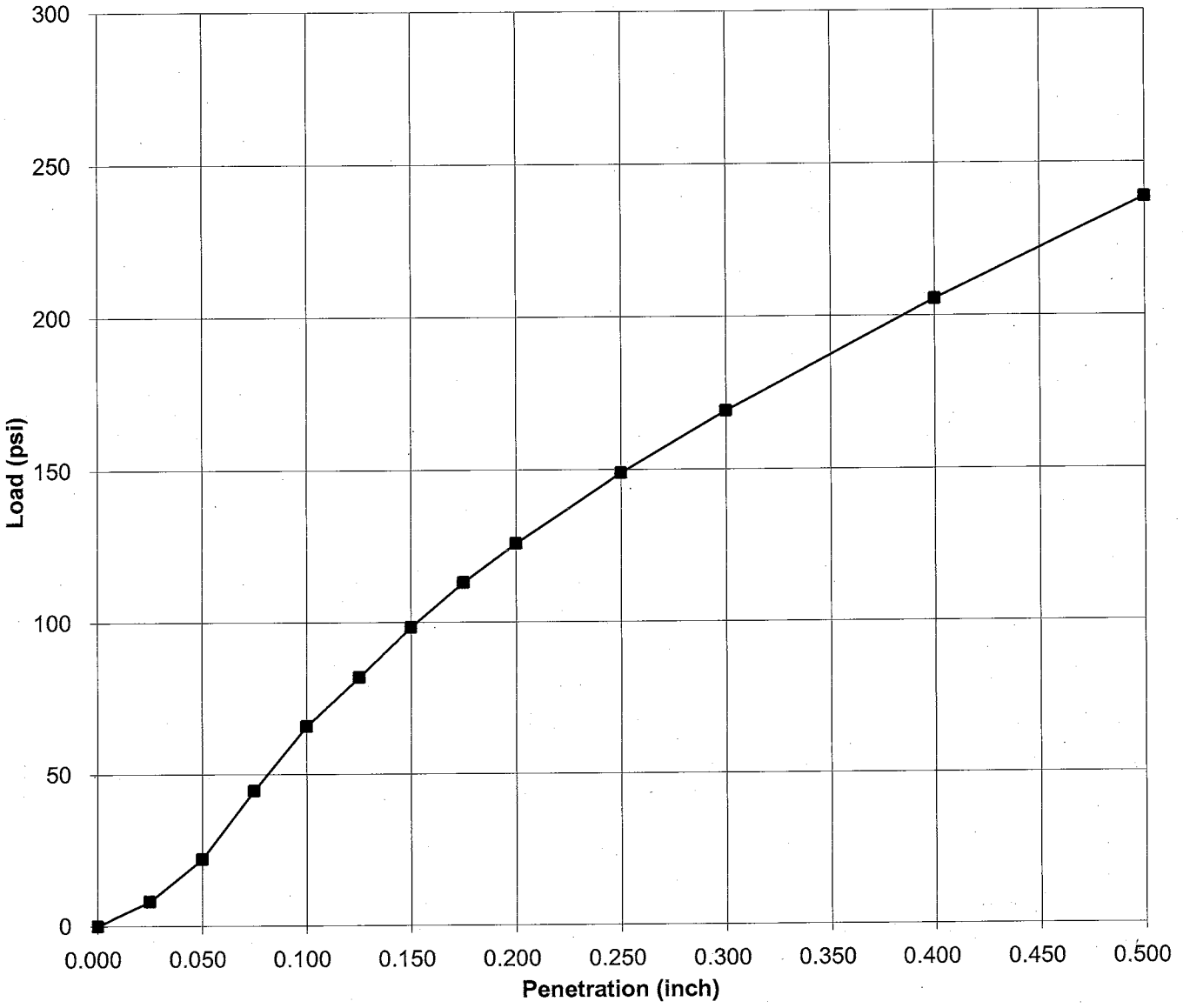
Reported By:

Sample Number: ROAD1-S1 Description: REDDISH BROWN SILT W/SAND
Location: 0

Weight of Hammer (lbs):	5.5	Proctor Method:	D-698	Maximum Dry Density (pcf):	105.8
Number of Layers:	3	Percent +4 Material:	3.6	Optimum Moisture Content (%):	18.0
Surcharge (lbs):	10				

Blows per Lift	CBR @ 0.1"	CBR @ 0.2"	Percent of Maximum Density	Molded +/ Optimum Moisture Content (%)	Molded Dry Density (pcf)	Molded Moisture Content (%)	Dry Density after Soaking (pcf)	Moisture Content after Soaking (%)	Change in Moisture Content (%)	Swell (%)
25	0.7	1.2	93.9	2.2	99.3	20.2	95.0	27.6	7.4	4.3
56	0.7	1.3	98.8	2.2	104.5	20.2	99.9	24.5	4.3	4.9

CBR Penetration



Sample No.: ROAD5-S3	Street: 0
Description: REDDISH BROWN SANDY SILT	Station No.: 0
Classification: ML	Test Method: D-1883

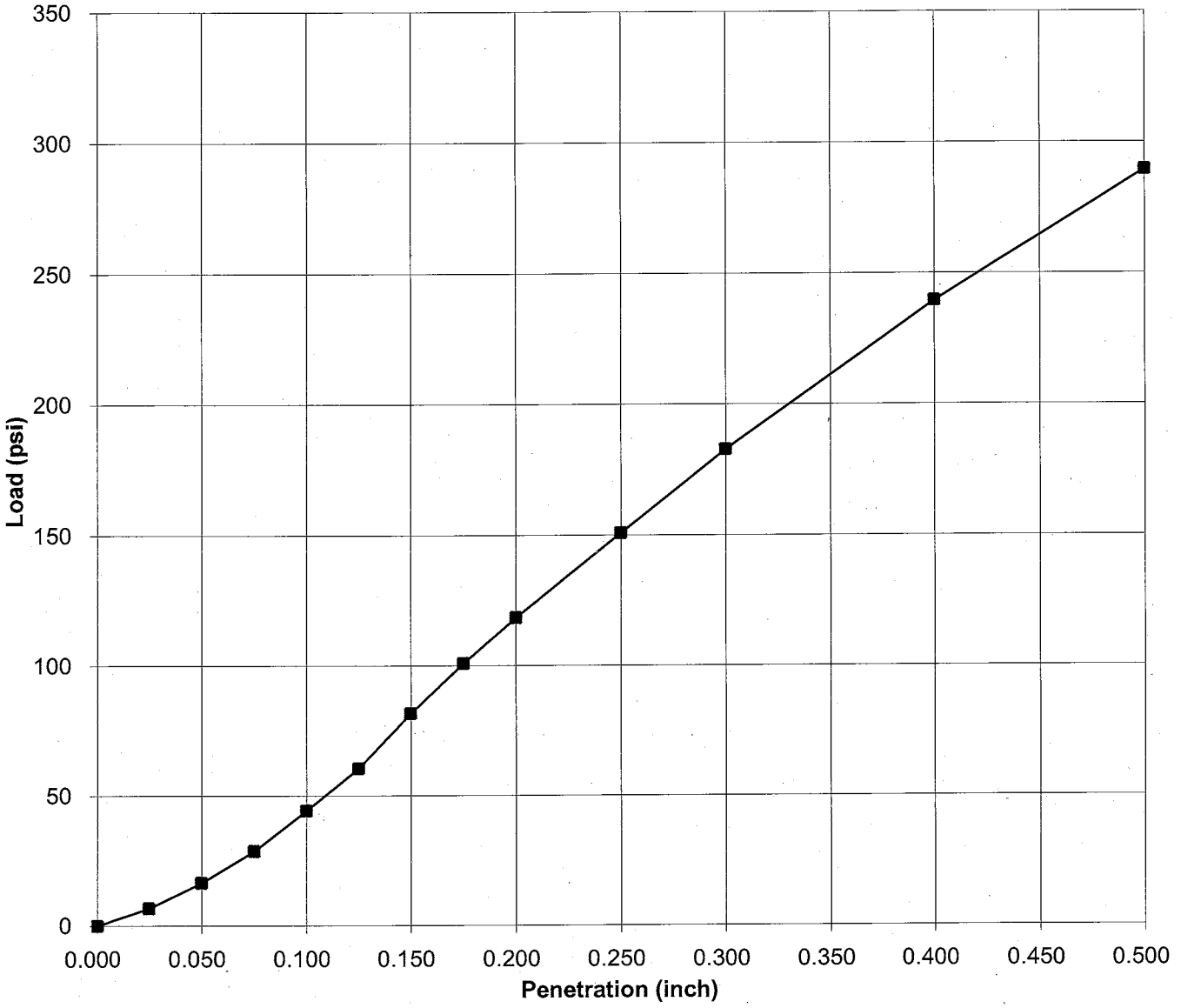
Maximum Dry Density (pcf)	116.5
Opt. Moisture Content (%)	15.3
Natural Moisture Content	8.3
Liquid Limit (LL)	38
Plastic Limit (PL)	26
Plasticity Index (PI)	12
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	3.4
Percent Retained No. 4 Sieve	11.9
Percent Passing No.200 Sieve	53.0

	CBR 1
Corrected CBR @ 0.1"	6.6
Corrected CBR @ 0.2"	8.4
Proctor Method	D-698
Dry Density as Molded	109.2
Molded Moisture Content	16.8
Percent of Maximum Density	93.7
Moisture Content +/- Opt	1.5
Percent (%)Swell	0.8

Project: GOLDENROD LANE EXT.
Project No.: 4436
Date: 05/06/11

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

CBR Penetration



Sample No.: ROAD5-S3	Street: 0
Description: REDDISH BROWN SANDY SILT	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	116.5
Opt. Moisture Content (%)	15.3
Natural Moisture Content	8.3
Liquid Limit (LL)	38
Plastic Limit (PL)	26
Plasticity Index (PI)	12
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	3.4
Percent Retained No. 4 Sieve	11.9
Percent Passing No.200 Sieve	53.0

	CBR 2
Corrected CBR @ 0.1"	4.4
Corrected CBR @ 0.2"	7.9
Proctor Method	D-698
Dry Density as Molded	113.4
Molded Moisture Content	16.8
Percent of Maximum Density	97.3
Moisture Content +/- Opt	1.5
Percent (%)Swell	0.9

Project: GOLDENROD LANE EXT.
Project No.: 4436
Date: 05/06/11

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

Engineering Consulting Services, Ltd.
Frederick, Maryland

California Bearing Ratio
ASTM D-1883

Date: 6-May-11

Project Name: GOLDENROD LANE EXT.
Project Number: 4436

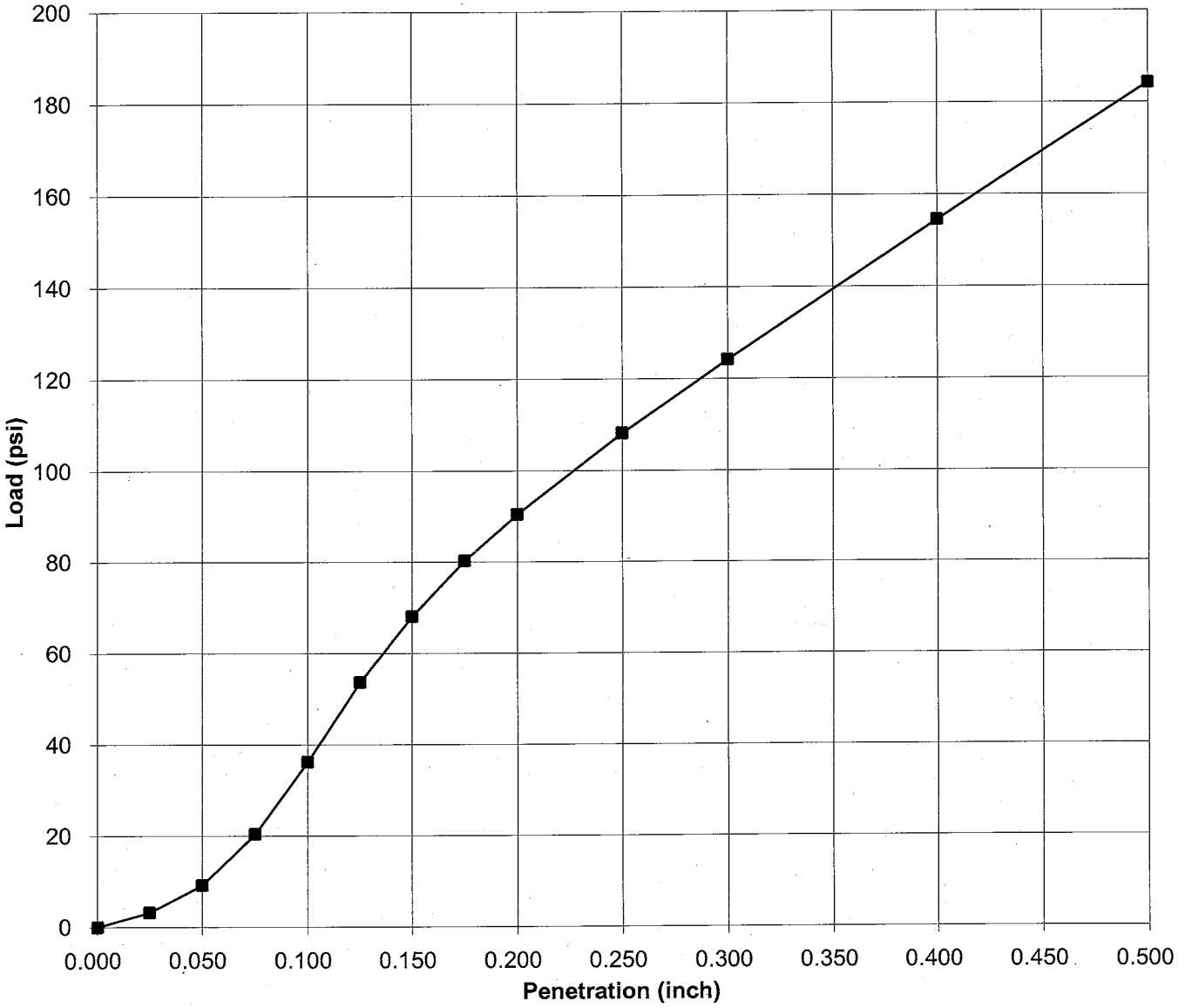
Reported By:

Sample Number: ROAD5-S3 Description: REDDISH BROWN SANDY SILT
Location: 0

Weight of Hammer (lbs):	5.5	Proctor Method:	D-698	Maximum Dry Density (pcf):	116.5
Number of Layers:	3	Percent +4 Material:	11.9	Optimum Moisture Content (%):	15.3
Surcharge (lbs):	10				

Blows per Lift	CBR @ 0.1"	CBR @ 0.2"	Percent of Maximum Density	Molded +/ Optimum Moisture Content (%)	Molded Dry Density (pcf)	Molded Moisture Content (%)	Dry Density after Soaking (pcf)	Moisture Content after Soaking (%)	Change in Moisture Content (%)	Swell (%)
25	6.6	8.4	93.7	1.5	109.2	16.8	108.6	19.0	2.2	0.8
56	4.4	7.9	97.3	1.5	113.4	16.8	113.1	17.1	0.3	0.9

CBR Penetration



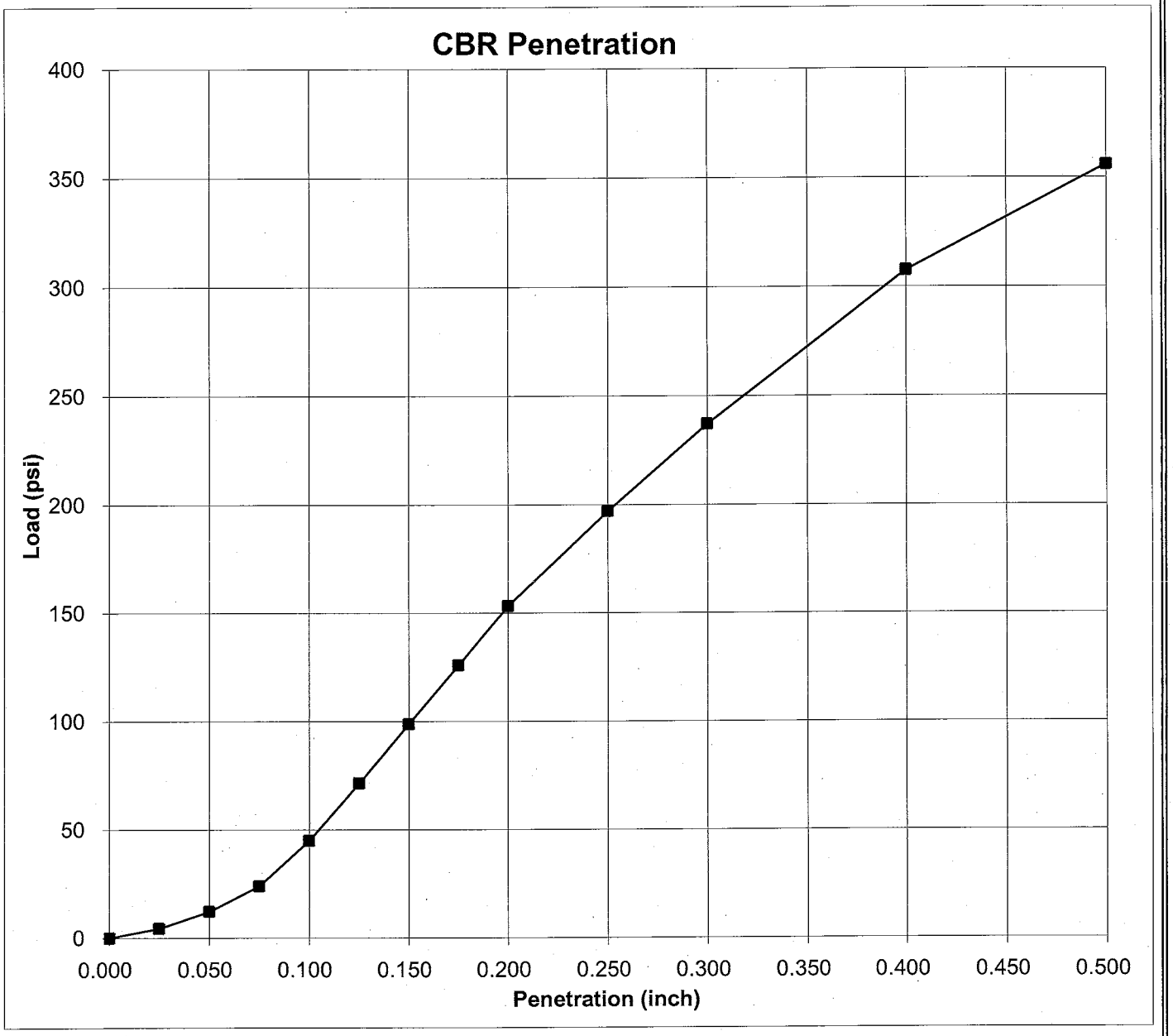
Sample No.: ROAD6-S5	Street: 0
Description: REDDISH BROWN SANDY SILT	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	118.5
Opt. Moisture Content (%)	13.5
Natural Moisture Content	5.7
Liquid Limit (LL)	36
Plastic Limit (PL)	25
Plasticity Index (PI)	11
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	
Percent Retained No. 4 Sieve	7.9
Percent Passing No.200 Sieve	55.0

	CBR 1
Corrected CBR @ 0.1"	3.6
Corrected CBR @ 0.2"	6.0
Proctor Method	D-698
Dry Density as Molded	110.8
Molded Moisture Content	14.4
Percent of Maximum Density	93.5
Moisture Content +/- Opt	0.9
Percent (%)Swell	1.6

Project: GOLDENROD LANE EXT.
Project No.: 4436
Date: 05/06/11

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves



Sample No.: ROAD6-S5	Street: 0
Description: REDDISH BROWN SANDY SILT	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	118.5
Opt. Moisture Content (%)	13.5
Natural Moisture Content	5.7
Liquid Limit (LL)	36
Plastic Limit (PL)	25
Plasticity Index (PI)	11
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	
Percent Retained No. 4 Sieve	7.9
Percent Passing No.200 Sieve	55.0

	CBR 2
Corrected CBR @ 0.1"	4.5
Corrected CBR @ 0.2"	10.2
Proctor Method	D-698
Dry Density as Molded	116.1
Molded Moisture Content	14.4
Percent of Maximum Density	98.0
Moisture Content +/- Opt	0.9
Percent (%)Swell	1.4

Project: GOLDENROD LANE EXT.
Project No.: 4436
Date: 05/06/11

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

Engineering Consulting Services, Ltd.
Frederick, Maryland

California Bearing Ratio
ASTM D-1883

Date: 6-May-11

Project Name: GOLDENROD LANE EXT.
Project Number: 4436

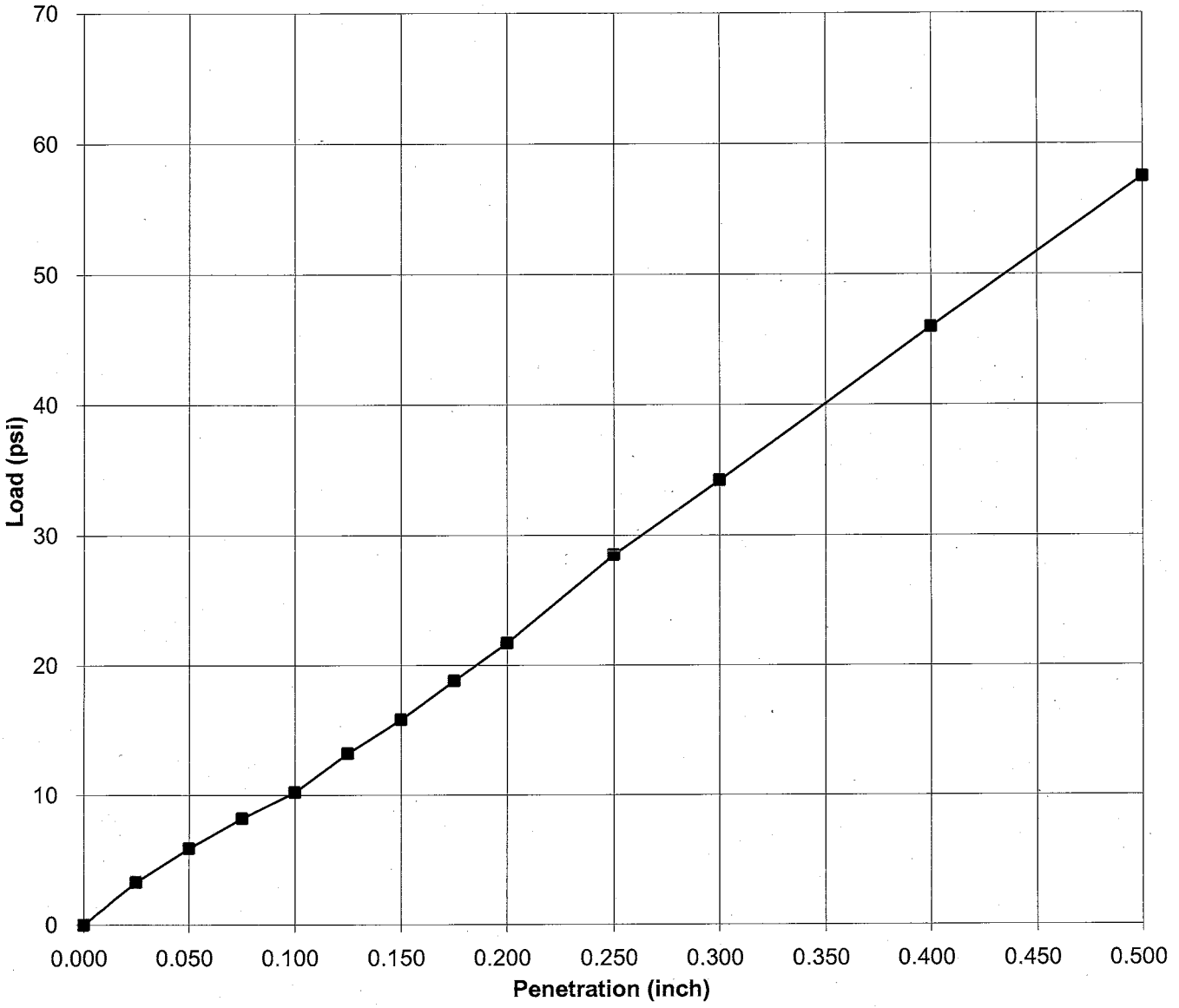
Reported By:

Sample Number: ROAD6-S5 Description: REDDISH BROWN SANDY SILT
Location: 0

Weight of Hammer (lbs):	5.5	Proctor Method:	D-698	Maximum Dry Density (pcf):	118.5
Number of Layers:	3	Percent +4 Material:	7.9	Optimum Moisture Content (%):	13.5
Surcharge (lbs):	10				

Blows per Lift	CBR @ 0.1"	CBR @ 0.2"	Percent of Maximum Density	Molded +/ Optimum Moisture Content (%)	Molded Dry Density (pcf)	Molded Moisture Content (%)	Dry Density after Soaking (pcf)	Moisture Content after Soaking (%)	Change in Moisture Content (%)	Swell (%)
25	3.6	6.0	93.5	0.9	110.8	14.4	110.0	18.3	3.9	1.6
56	4.5	10.2	98.0	0.9	116.1	14.4	114.5	16.7	2.3	1.4

CBR Penetration



Sample No.: ROAD7-S3	Street: 0
Description: REDDISH BROWN SILT W/SAND	Station No.: 0
Classification: ML	Test Method: D-1883

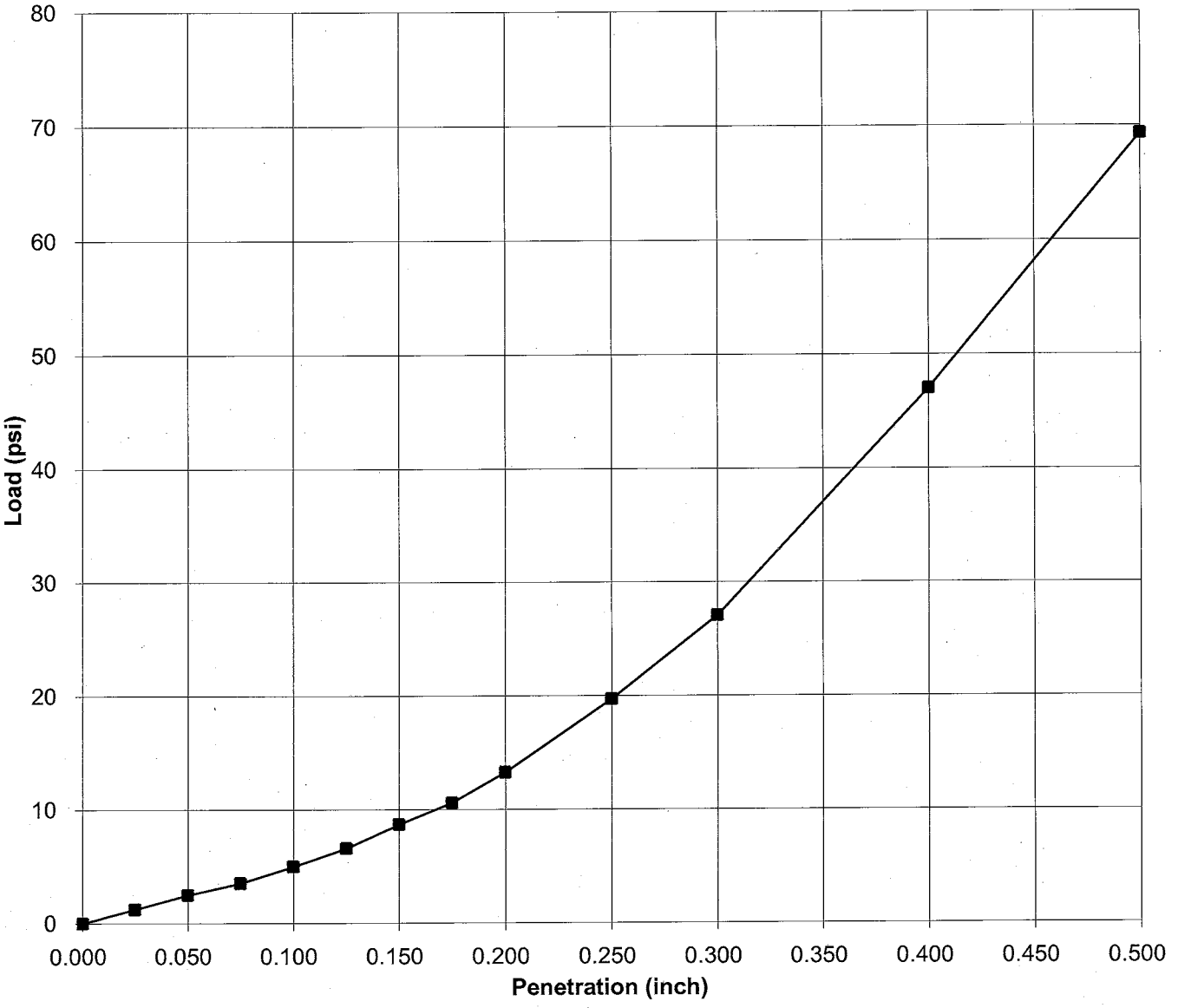
Maximum Dry Density (pcf)	104.4
Opt. Moisture Content (%)	18.4
Natural Moisture Content	19.2
Liquid Limit (LL)	41
Plastic Limit (PL)	28
Plasticity Index (PI)	13
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	
Percent Retained No. 4 Sieve	3.5
Percent Passing No.200 Sieve	70.0

	CBR 1
Corrected CBR @ 0.1"	1.0
Corrected CBR @ 0.2"	1.4
Proctor Method	D-698
Dry Density as Molded	100.3
Molded Moisture Content	20.0
Percent of Maximum Density	96.1
Moisture Content +/- Opt	1.6
Percent (%)Swell	4.4

Project: GOLDENROD LANE EXT
Project No.: 4436
Date: 05/06/11

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

CBR Penetration



Sample No.: ROAD7-S3	Street: 0
Description: REDDISH BROWN SILT W/SAND	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	104.4
Opt. Moisture Content (%)	18.4
Natural Moisture Content	19.2
Liquid Limit (LL)	41
Plastic Limit (PL)	28
Plasticity Index (PI)	13
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	
Percent Retained No. 4 Sieve	3.5
Percent Passing No.200 Sieve	70.0

	CBR 2
Corrected CBR @ 0.1"	0.5
Corrected CBR @ 0.2"	0.9
Proctor Method	D-698
Dry Density as Molded	103.3
Molded Moisture Content	20.0
Percent of Maximum Density	98.9
Moisture Content +/- Opt	1.6
Percent (%)Swell	4.8

Project: GOLDENROD LANE EXT
Project No.: 4436
Date: 05/06/11

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

Engineering Consulting Services, Ltd.
Frederick, Maryland

California Bearing Ratio
ASTM D-1883

Date: 6-May-11

Project Name: GOLDENROD LANE EXT
Project Number: 4436

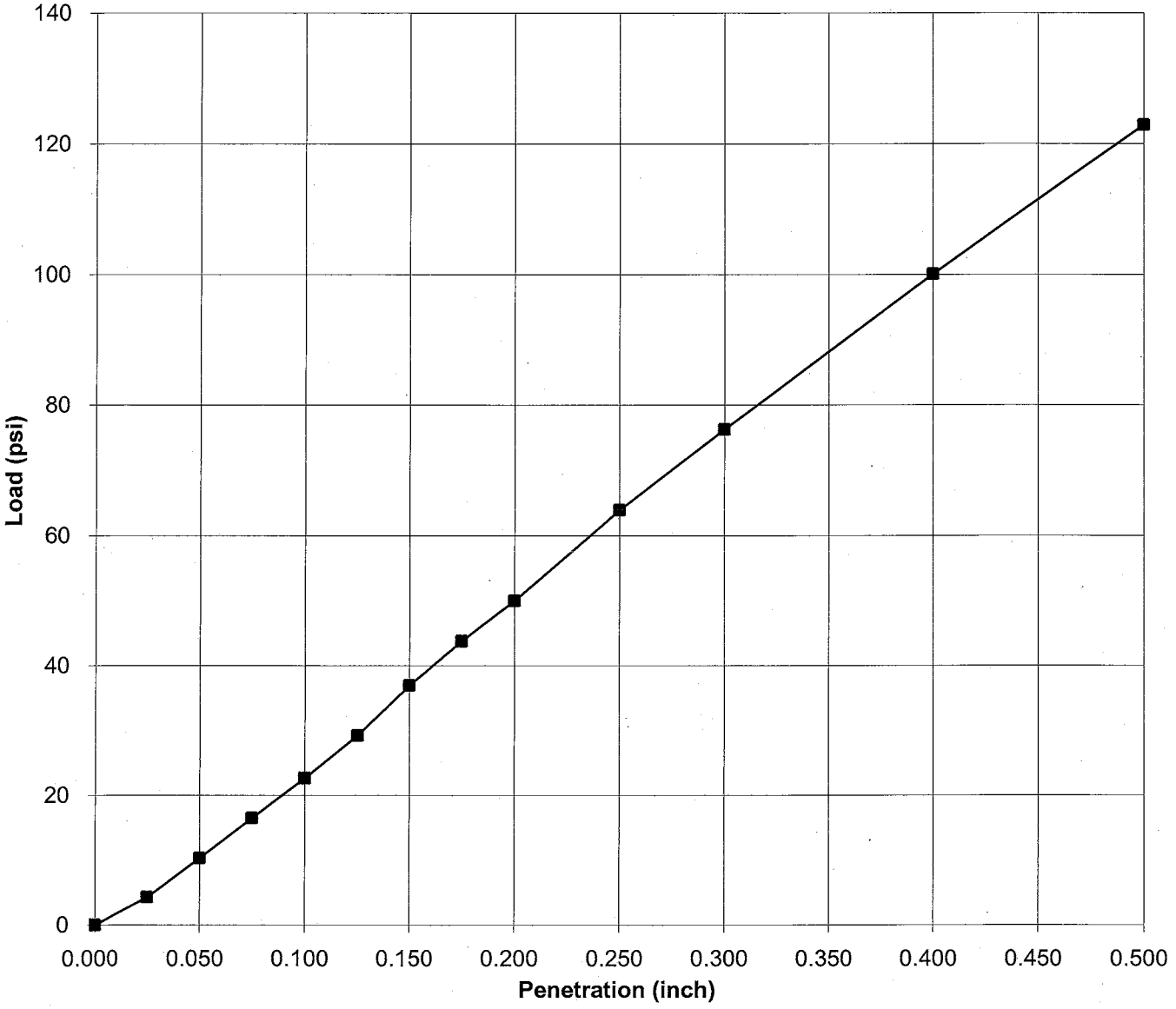
Reported By:

Sample Number: ROAD7-S3 Description: REDDISH BROWN SILT W/SAND
Location: 0

Weight of Hammer (lbs):	5.5	Proctor Method:	D-698	Maximum Dry Density (pcf):	104.4
Number of Layers:	3	Percent +4 Material:	3.5	Optimum Moisture Content (%):	18.4
Surcharge (lbs):	10				

Blows per Lift	CBR @ 0.1"	CBR @ 0.2"	Percent of Maximum Density	Molded +/- Optimum Moisture Content (%)	Molded Dry Density (pcf)	Molded Moisture Content (%)	Dry Density after Soaking (pcf)	Moisture Content after Soaking (%)	Change in Moisture Content (%)	Swell (%)
25	1.0	1.4	96.1	1.6	100.3	20.0	96.2	26.1	6.1	4.4
56	0.5	0.9	98.9	1.6	103.3	20.0	98.2	24.8	4.8	4.8

CBR Penetration

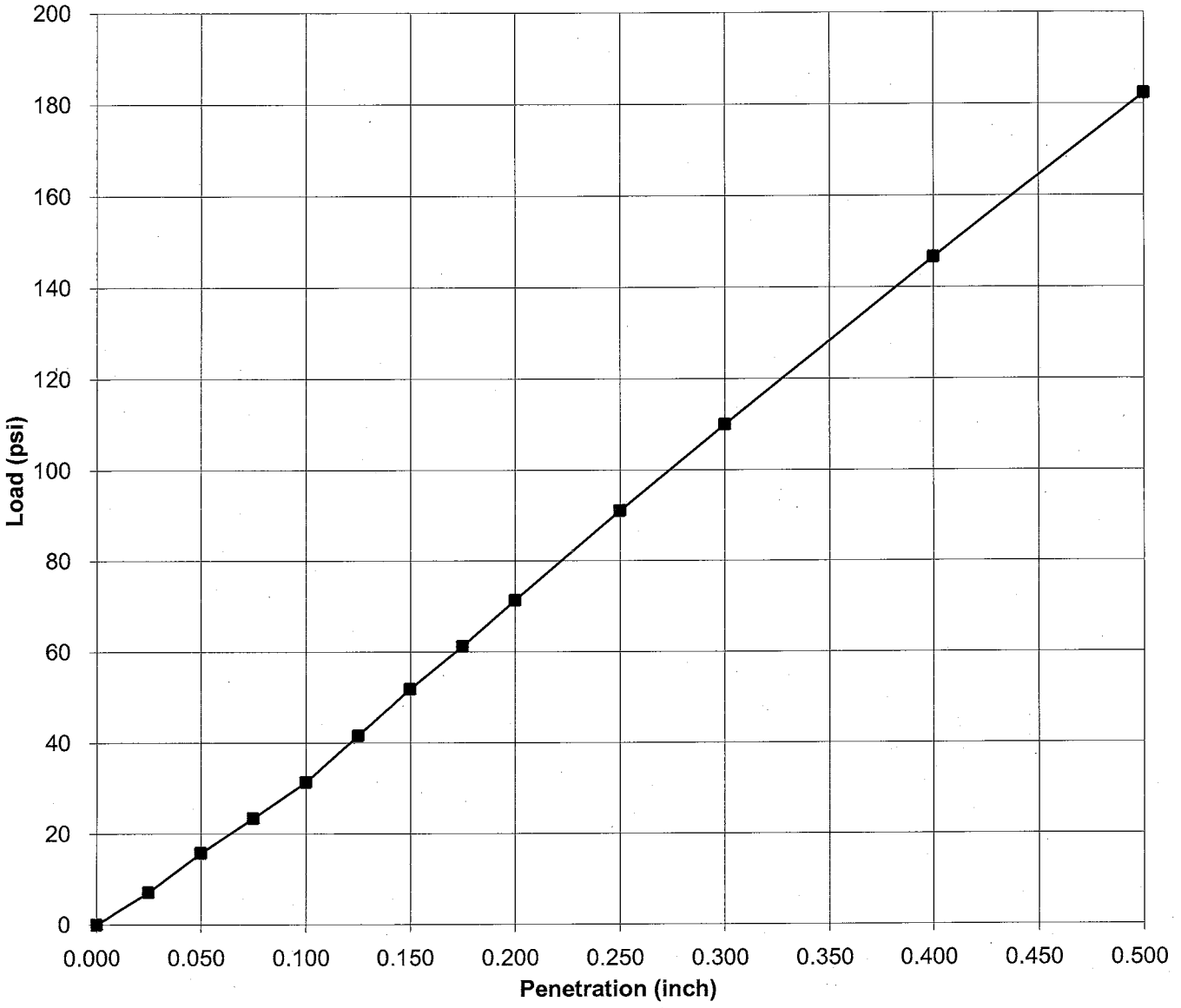


Sample No.: ROAD8-S2	Street: 0
Description: REDDISH BROWN SILT W/SAND	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	109.5		CBR 1
Opt. Moisture Content (%)	15.1	Corrected CBR @ 0.1"	2.3
Natural Moisture Content	22.9	Corrected CBR @ 0.2"	3.3
Liquid Limit (LL)	44	Proctor Method	D-698
Plastic Limit (PL)	29	Dry Density as Molded	104.4
Plasticity Index (PI)	15	Molded Moisture Content	17.6
Liquidity Index (LI)		Percent of Maximum Density	95.3
Percent Retained 3/4" Sieve		Moisture Content +/- Opt	2.5
Percent Retained No. 4 Sieve	4.2	Percent (%)Swell	2.5
Percent Passing No.200 Sieve	71.0		

Project: GOLDENROD LANE EXT.	**ECS MID-ATLANTIC, LLC**
Project No.: 4436	**Frederick, Maryland**
Date: 05/06/11	**California Bearing Ratio Curves**

CBR Penetration



Sample No.: ROAD8-S2	Street: 0
Description: REDDISH BROWN SILT W/SAND	Station No.: 0
Classification: ML	Test Method: D-1883

Maximum Dry Density (pcf)	109.5
Opt. Moisture Content (%)	15.1
Natural Moisture Content	22.9
Liquid Limit (LL)	44
Plastic Limit (PL)	29
Plasticity Index (PI)	15
Liquidity Index (LI)	
Percent Retained 3/4" Sieve	
Percent Retained No. 4 Sieve	4.2
Percent Passing No.200 Sieve	71.0

	CBR 2
Corrected CBR @ 0.1"	3.1
Corrected CBR @ 0.2"	4.8
Proctor Method	D-698
Dry Density as Molded	108.8
Molded Moisture Content	17.6
Percent of Maximum Density	99.4
Moisture Content +/- Opt	2.5
Percent (%)Swell	2.6

Project: GOLDENROD LANE EXT.
Project No.: 4436
Date: 05/06/11

ECS MID-ATLANTIC, LLC
Frederick, Maryland
California Bearing Ratio Curves

Engineering Consulting Services, Ltd.
Frederick, Maryland

California Bearing Ratio
ASTM D-1883

Date: 6-May-11

Project Name: GOLDENROD LANE EXT.
Project Number: 4436

Reported By:

Sample Number: ROAD8-S2 Description: REDDISH BROWN SILT W/SAND
Location: 0

Weight of Hammer (lbs):	5.5	Proctor Method:	D-698	Maximum Dry Density (pcf):	109.5
Number of Layers:	3	Percent +4 Material:	4.2	Optimum Moisture Content (%):	15.1
Surcharge (lbs):	10				

Blows per Lift	CBR @ 0.1"	CBR @ 0.2"	Percent of Maximum Density	Molded +/ Optimum Moisture Content (%)	Molded Dry Density (pcf)	Molded Moisture Content (%)	Dry Density after Soaking (pcf)	Moisture Content after Soaking (%)	Change in Moisture Content (%)	Swell (%)
25	2.3	3.3	95.3	2.5	104.4	17.6	101.6	23.1	5.5	2.5
56	3.1	4.8	99.4	2.5	108.8	17.6	105.5	21.5	3.9	2.6

REFERENCE NOTES FOR BORING LOGS

I. Drilling Sampling Symbols

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, BX, AX	PM	Pressuremeter
DC	Dutch Cone Penetrometer	RD	Rock Bit Drilling
BS	Bulk Sample of Cuttings	PA	Power Auger (no sample)
HSA	Hollow Stem Auger	WS	Wash sample
REC	Rock Sample Recovery %	RQD	Rock Quality Designation %

II. Correlation of Penetration Resistances to Soil Properties

Standard Penetration (blows/ft) refers to the blows per foot of a 140 lb. hammer falling 30 inches on a 2-inch OD split-spoon sampler, as specified in ASTM D 1586. The blow count is commonly referred to as the N-value.

A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

Density		*Relative Properties*	
Under 4 blows/ft	Very Loose	Adjective Form	12% to 49%
5 to 10 blows/ft	Loose	With	5% to 12%
11 to 30 blows/ft	Medium Dense		
31 to 50 blows/ft	Dense		
Over 51 blows/ft	Very Dense		

Particle Size Identification		
Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ inch
Sand	Coarse	2.00 mm to ¼ inch (dia. of lead pencil)
	Medium	0.42 to 2.00 mm (dia. of broom straw)
	Fine	0.074 to 0.42 mm (dia. of human hair)
Silt and Clay		0.0 to 0.074 mm (particles cannot be seen)

B. Cohesive Soils (Clay, Silt, and Combinations)

Blows/ft	*Consistency*	*Unconfined Comp. Strength Q_p (tsf)*	*Degree of Plasticity*	*Plasticity Index*
Under 2	Very Soft	Under 0.25	None to slight	0 – 4
3 to 4	Soft	0.25-0.49	Slight	5 – 7
5 to 8	Medium Stiff	0.50-0.99	Medium	8 – 22
9 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.00		
31 to 50	Hard	4.00–8.00		
Over 51	Very Hard	Over 8.00		

III. Water Level Measurement Symbols

WL	Water Level	BCR	Before Casing Removal	DCI	Dry Cave-In
WS	While Sampling	ACR	After Casing Removal	WCI	Wet Cave-In
WD	While Drilling	▽	Est. Groundwater Level	⊽	Est. Seasonal High GWT

The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally applied.

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD–1	1 OF 1
PROJECT NAME	**ARCHITECT–ENGINEER**		
Goldenrod Lane Extension			

SITE LOCATION
Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 562.19

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)
0					Topsoil Depth 6”	
	1	SS	18	16	SILT, With Clay, Reddish Brown, Moist, Loose, (ML)	560
	2	SS	18	14	SILT, Trace Weathered Rock, Reddish Brown, Medium Dense, (ML)	
5	3	SS	18	16		555
	4	SS	18	16		
10						550
	5	SS	18	12	SILT, With Weathered Rock and Trace Quartz, Yellowish Brown to Brown, Dense, (ML)	
15						545
	6	SS	17	10	Weathered Rock, With Quartz, Grayish Brown, Moist, Very Dense	
20					END OF BORING @ 19.9’	540
25						535
30						

4 (1-2-2)
22.528
44
16 (4-7-9)
14.5
12 (4-5-7)
17.3
18 (5-8-10)
(14-17-22) 39
(17-39-50/5) 89/11

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/29/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/29/11	CAVE IN DEPTH @ 14.8’
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)
GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD–2	1 OF 1
PROJECT NAME	**ARCHITECT–ENGINEER**		
Goldenrod Lane Extension			

SITE LOCATION
Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 546.95

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6”		
	1	SS	18	16	SILT, Trace Weathered Rock, Reddish Brown, Moist, Medium Dense, (ML)	545	11 (4-5-6)
5	2	SS	18	18			15 (5-7-8)
	3	SS	18	18		540	13 (4-6-7)
	4	SS	18	18			16 (5-7-9)
10						535	
	5	SS	18	14	SILT, With Weathered Rock, Reddish Brown, Moist, Dense to Very Dense, (ML)		(11-15-19) 34
15						530	
	6	SS	18	14			(13-20-34) 54
20					END OF BORING @ 20.0’	525	
						520	
25							
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/29/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/29/11	CAVE IN DEPTH @ 15.3’
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)
(04/20/2011)
GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Goldenrod Lane Extension	

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% —— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT.: ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 531.54

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 8"		530	
	1	SS	18	18	SILT, With Weathered Rock, Reddish Brown, Moist, Firm to Medium Dense, (ML)			⊗ 7 (2-3-4)
5	2	SS	18	18			525	⊗ 10 (3-4-6)
	3	SS	18	18				⊗ 11 (3-5-6)
	4	SS	18	18			520	⊗ 15 (4-6-9)
10								
	5	SS	18	16			515	⊗ 24 (10-12-12)
15								
	6	SS	18	12	Weathered Rock, With Sandy Silt and Rock Fragments, Brown, Moist, Very Dense			(18-26-41) ⊗ 67
20					END OF BORING @ 20.0'		510	
25							505	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/29/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/29/11	CAVE IN DEPTH @ AT EOD 15.8
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)

(03/29/2011) GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD–4	1 OF 1

PROJECT NAME	ARCHITECT–ENGINEER
Goldenrod Lane Extension	

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% ——— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT.: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 532.39

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0						530	
							Topsoil Depth 4"
	1	SS	18	16			SILT, Trace Rock Fragments, Reddish Brown, Moist, Firm to Medium Dense, (ML) — 9 (3-4-5)
	2	SS	18	18			20 (6-9-11)
5						525	
	3	SS	18	18			15 (5-7-8)
	4	SS	18	14			19 (7-9-10)
10						520	
	5	SS	18	16			26 (6-11-15)
15						515	
	6	SS	11	8			Weathered Rock, With Sandy Silt, Brownish Gray, Moist, Very Dense, (ML) — (39-50/5) 50/5
20						510	
							END OF BORING @ 19.4'
25						505	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/28/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/28/11	CAVE IN DEPTH @ 0.0'
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)

(03/29/2011) GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD–5	1 OF 1

PROJECT NAME	ARCHITECT–ENGINEER
Goldenrod Lane Extension	

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% — 20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 555.59

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)
0					555
	1	SS	18	16	
	2	SS	18	14	
5					550
	3	SS	18	14	
	4	SS	18	14	
10					545
	5	SS	18	18	
15					540
	6	SS	2	2	
20					535
	7	SS	0	0	
25					530
30					

Topsoil Depth 6”

SILT, Trace Rock Fragments, Brown to Purplish Brown, Moist, Medium Dense to Dense, (ML)

Weathered Rock, With Sandy Silt and Rock Fragments, Gray, Moist, Very Dense, (ML)

AUGER REFUSAL @ 21.0’

12 (3-5-7)
12.6
16 (6-8-8)
9.7
26 (8-11-15)
8.3
26
38
(14-22-17) 39
11.2
19 (5-7-12)
18.1
(50/2) 50/2
(50/0) 50/0

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A	WS OR WD	BORING STARTED 03/28/11	DRILLER: D&S
▽WL(BCR)	▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/28/11	CAVE IN DEPTH @ 14.9’
▽WL		RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)

(03/28/2011) GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD-6	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Goldenrod Lane Extension	

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% — 20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 568.64

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	DESCRIPTION OF MATERIAL
0						568.64	Topsoil Depth 6"
	1	SS	18	16			SILT, Trace Rock Fragments, Reddish Brown, Moist, Firm to Dense, (ML)
5	2	SS	18	16		565	
	3	SS	18	14			
	4	SS	9	8		560	Weathered Rock, With Silt and Rock Fragments, Grayish Brown to Gray, Moist, Very Dense, (ML)
10							
	5	SS	2	1		555	
15							
	6	SS	5	5		550	
20							
	7	SS	4	4		545	
25							
	8	SS	0	0		540	AUGER REFUSAL @ 28.0'
30							

⊗ 10 (3-4-6) ● 19.7 ⊗ 15 (4-6-9) ● 18.7 (12-17-24) ⊗ 41 ● 12.0 ● 8.1 (24-50/3) ⊗ 50/3 (50/2) ⊗ 50/2 ● 5.7 × 25 △ 36 ● 7.5 (50/5) ⊗ 50/5 (50/4) ⊗ 50/4 (50/0) ⊗ 50/0

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/25/11	DRILLER: D&S
▽WL(BCR) ▽WL(ACR) DRY AT EOD	BORING COMPLETED 03/25/11	CAVE IN DEPTH @ 19.9'
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)

(04/20/2011) GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD-7	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Goldenrod Lane Extension	

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% —— 20% 40% 60% 80% 100%

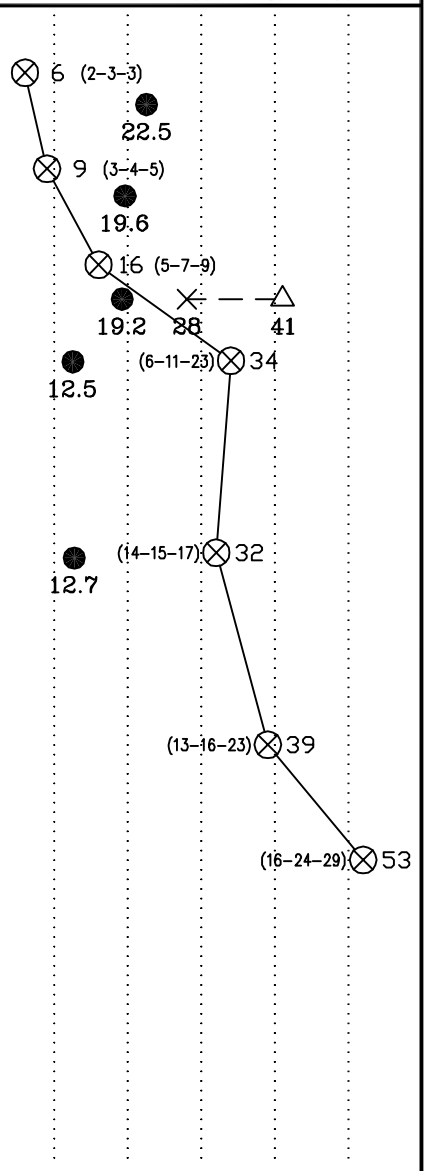
⊗ STANDARD PENETRATION BLOWS/FT.: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 555.00

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)
0					
					Topsoil Depth 6"
	1	SS	18	18	SILT, Trace Weathered Rock, Reddish Brown, Moist, Loose to Medium Dense, (ML)
	2	SS	18	18	
5					550
	3	SS	18	16	
	4	SS	18	14	SILT, With Weathered Rock, Grayish Red, Moist, Dense to Very Dense, (ML)
10					545
	5	SS	18	16	
15					540
	6	SS	18	16	
20					535
	7	SS	18	14	
25					530
					END OF BORING @ 23.0'
30					



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/25/11	DRILLER: D&S
▽WL(BCR) ▽WL(ACR) DRY AT EOD	BORING COMPLETED 03/25/11	CAVE IN DEPTH @ 16.4'
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

(04/20/2011)

GRatkowski

ahewitt (05-10-11)

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD-8	1 OF 1
PROJECT NAME	**ARCHITECT-ENGINEER**		
Goldenrod Lane Extension			

SITE LOCATION
Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2} 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.% ——
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 503.23

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)
0					Topsoil Depth 4"	
	1	SS	18	18	SILT, Reddish Brown, Moist, Firm to Medium Dense, (ML)	
	2	SS	18	18		500
5						
	3	SS	18	18	SILT, Trace Rock Fragments, Brown, Moist, Medium Dense to Dense, (ML)	
	4	SS	18	18		495
10					Weathered Rock, With Silt and Rock Fragments, Gray, Moist, Dense, (ML)	
	5	SS	0	0	AUGER REFUSAL @ 12.0'	490
15						
						485
20						
						480
25						
						475
30						

⊗ 6 (2-3-3) ● 23.0
⊗ 12 (3-5-7) ● 22.9 × 29 △ 44
⊗ 13 (5-6-7) ● 10.9
● 4.1 (6-11-20) ⊗ 31
(50/0) ⊗ 50/0

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/25/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/25/11	CAVE IN DEPTH @ 8.9'
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)
(04/20/2011)
GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	ROAD–9	1 OF 1

PROJECT NAME	ARCHITECT–ENGINEER
Goldenrod Lane Extension	

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% ——— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT.: ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 503.23

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6”		
	1	SS	18	14	SILT, Trace Rock Fragments, Reddish Brown, Moist, Firm to Medium Dense, (ML)	500	8 (2–3–5)
	2	SS	18	16			13 (4–6–7)
5	3	SS	18	16			10 (3–5–5)
	4	SS	18	18		495	11 (4–5–6)
10							
	5	SS	18	16		490	17 (5–7–10)
15							
	6	SS	18	16	SILT, With Weathered Rock, Brown, Moist, Dense, (ML)	485	(8–14–17) 31
20					END OF BORING @ 20.0’		
						480	
25							
						475	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/25/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/25/11	CAVE IN DEPTH @ 14.9’
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)

(04/20/2011) GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	SWM–1	1 OF 1

PROJECT NAME	ARCHITECT–ENGINEER
Goldenrod Lane Extension	

SITE LOCATION
Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}
1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY
RQD% — — — REC.%
20% 40% 60% 80% 100%

⊗ STANDARD PENETRATION BLOWS/FT.
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 520.31

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					520	
						Topsoil Depth 6"
	1	SS	18	18		6 (2-3-3)
						SILT, Trace Rock and Quartz Fragments, Reddish Brown, Moist, Firm to Medium Dense, (ML)
	2	SS	18	14		9 (4-5-4)
5					515	
	3	SS	18	18		11 (3-5-6)
	4	SS	18	18		19 (5-8-11)
10					510	
	5	SS	18	14		(11-18-25) 43
						SILT, With Weathered Rock, Purplish Black and Brown, Moist, Dense to Very Dense, (ML)
15					505	
	6	SS	18	14		(19-29-34) 63
20					500	
						END OF BORING @ 20.0'
25					495	
30						

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/28/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/28/11	CAVE IN DEPTH @ 15.2'
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)
(03/25/2011)
GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	SWM-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Goldenrod Lane Extension	

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% —— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT.: ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 513.45

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		513.45	
	1	SS	18	16	SAND, Trace Clay, Reddish Brown, Moist, Firm, (SC)			8 (2-3-5)
	2	SS	18	14	SILT, Trace Rock Fragments, Brown, Moist, Dense, (ML)		510	(7-12-19) 31
5	3	SS	11	8	Weathered Rock, With Silt, Brown, Moist, Very Dense			(36-50/5) 50/5
	4	SS	18	14	SILT, With Weathered Rock and Rock Fragments, Grayish Brown, Moist, Dense, (ML)		505	(10-24-22) 46
10								
	5	SS	18	12			500	(9-15-23) 38
15								
	6	SS	18	14			495	(12-15-20) 35
20					END OF BORING @ 20.0'			
							490	
25								
							485	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/28/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/28/11	CAVE IN DEPTH @ 14.2'
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)

(03/28/2011) GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	SWM-3	1 OF 1
PROJECT NAME	**ARCHITECT-ENGINEER**		
Goldenrod Lane Extension			

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% ——— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT.: ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 503.29

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"			
	1	SS	18	14	SILT, Trace Clay, Reddish Brown, Moist, Loose to Firm, (ML)		500	⊗ 5 (2-2-3)
5	2	SS	18	18				⊗ 9 (3-4-5)
	3	SS	18	16	SILT, Trace Rock and Quartz Fragments, Dark Brown, Moist, Medium Dense, (ML)		495	⊗ 13 (4-6-7)
10	4	SS	18	16				⊗ 17 (5-7-10)
	5	SS	18	18		▽	490	⊗ 21 (6-9-12)
15							485	
	6	SS	18	12	SILT, With Weathered Rock, Brown, Moist, Dense, (ML)			(11-18-26) ⊗ 44
20					END OF BORING @ 20.0'		480	
25							475	
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL 18.00 (WS) OR WD	BORING STARTED 03/28/11	DRILLER: D&S
▽WL(BCR) ▽WL(ACR) DRY AT EOD	BORING COMPLETED 03/28/11	CAVE IN DEPTH @ 15.8'
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)

(03/28/2011) GRatkowski

CLIENT	JOB #	BORING #	SHEET
A. Morton Thomas & Associates	4436	SWM-4	1 OF 1
PROJECT NAME	**ARCHITECT-ENGINEER**		
Goldenrod Lane Extension			

SITE LOCATION: Goldenrod Lane, Germantown, MD

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC.% ——— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT.: ⊗ 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ▶ — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 492.07

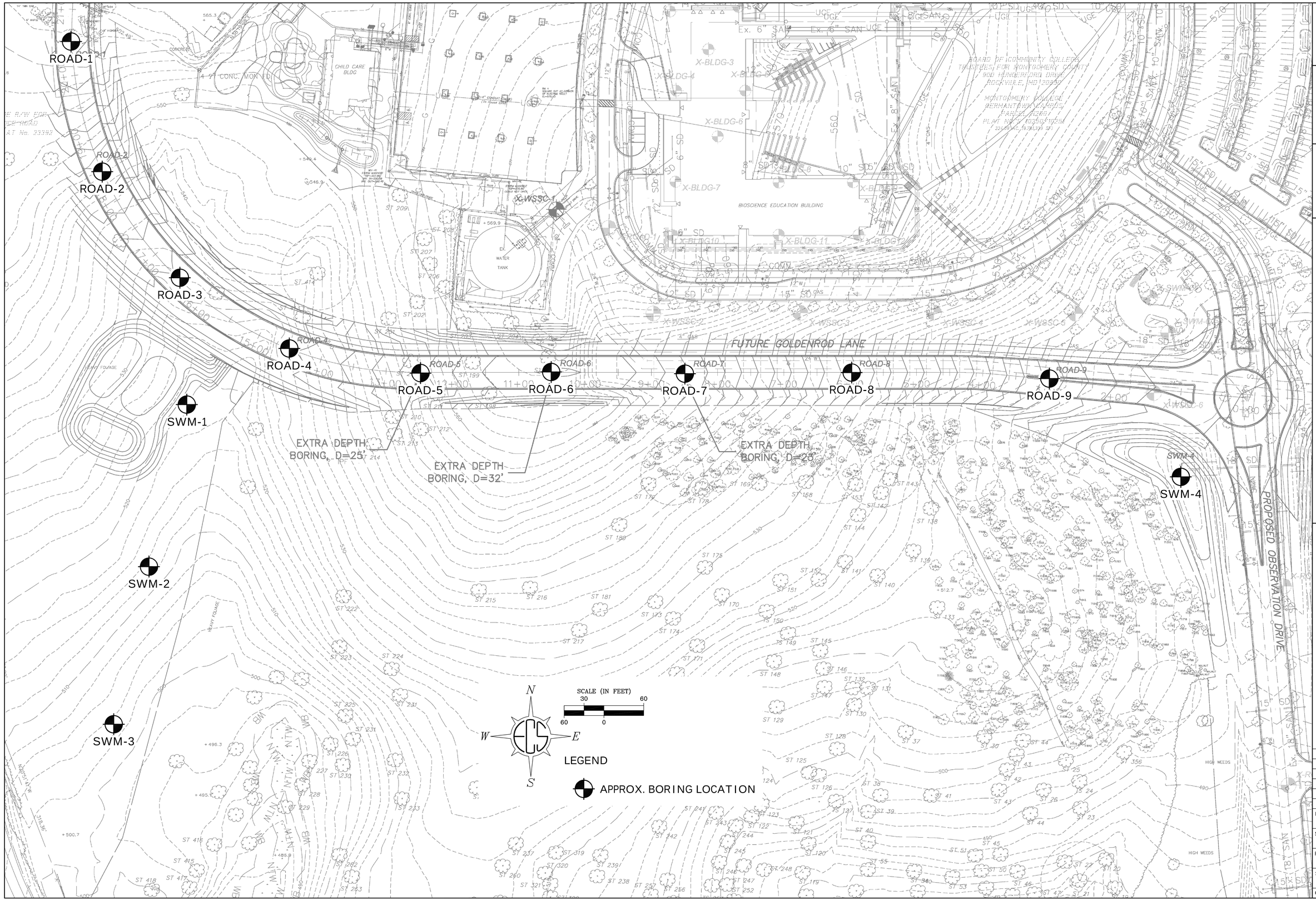
DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS ELEVATION (FT)	STANDARD PENETRATION BLOWS/FT.
0					Topsoil Depth 6"		
	1	SS	18	16	SILT, Trace Weathered Rock Fragments, Reddish Brown, Moist, Firm, (ML)	490	7 (2-3-4)
	2	SS	18	18			10 (3-4-6)
5	3	SS	18	18		485	8 (3-4-4)
	4	SS	18	18			10 (4-5-5)
10						480	
	5	SS	18	16	SILT, With Weathered Rock, Brownish Gray, Moist, Medium Dense to Dense, (ML)		26 (6-11-15)
15						475	
	6	SS	18	2			(9-15-18) 33
20					END OF BORING @ 20.0'	470	
25						465	
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

▽WL N/A (WS) OR WD	BORING STARTED 03/25/11	DRILLER: D&S
▽WL(BCR) ▼WL(ACR) DRY AT EOD	BORING COMPLETED 03/25/11	CAVE IN DEPTH @ 14.9'
▽WL	RIG 750 ATV FOREMAN D. Price	DRILLING METHOD HSA

ahewitt (05-10-11)

(03/28/2011) GRatkowski



CELEBRATING OVER 20 YEARS OF EXCELLENCE

SETTING THE STANDARD FOR SERVICE

ECS - MID-ATLANTIC, LLC
5112 Pegasus Court, Ste S
Frederick, MD 21704
TEL (301) 668-4303
FAX (301) 668-3519

GOLDENROD LANE EXTENSION

GERMANTOWN, MARYLAND

BORING LOCATION DIAGRAM

A. MORTON THOMAS & ASSOCIATES

ECS REVISIONS

ENGINEER	DRAFTING
GAR	AMH

SCALE	1" = 60'
PROJECT NO.	13-4436
SHEET	1 OF 1
DATE	05-10-11

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Site Retaining walls not connected to the building.

B. Related Sections:
1. Section 312000 "Earth Moving".
2. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect/Engineer.

E. Samples: For waterstops.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Field quality-control reports.

F. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 318-08 and ACI 350R-06

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.

2. Review inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. High-density overlay, Class 1 or better.
b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
c. Structural 1, B-B or better; mill oiled and edge sealed.
d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice".

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II, gray Supplement with the following:
   a. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag cement. Limit slag to 35% max by weight.

B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. BoMetals, Inc.
   b. Greenstreak.
   c. Paul Murphy Plastics Company.
   d. Vinylex Corp.

2. Profile: Ribbed without center bulb .
3. Dimensions: 9 inches by 3/8 inch; nontapered.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
b. BASF Construction Chemicals - Building Systems; Confilm.
c. ChemMasters; SprayFilm.
d. Conspec by Dayton Superior; Aquafilm.
e. Dayton Superior Corporation; Sure Film (J-74).
f. Edoco by Dayton Superior; BurkeFilm.
g. Euclid Chemical Company (The), an RPM company; Eucobar.
h. Kaufman Products, Inc.; Vapor-Aid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. BASF Construction Chemicals - Building Systems; Kure 200.
c. ChemMasters; Safe-Cure Clear.
d. Conspec by Dayton Superior; W.B. Resin Cure.
e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
f. Edoco by Dayton Superior; Res X Cure WB.
g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
h. Kaufman Products, Inc.; Thinfilm 420.
i. Lambert Corporation; AQUA KURE - CLEAR.
j. L&M Construction Chemicals, Inc.; L&M Cure R.
k. Meadows, W. R., Inc.; 1100-CLEAR.
l. Nox-Crete Products Group; Resin Cure E.

m. Right Pointe; Clear Water Resin.
n. SpecChem, LLC; Spec Rez Clear.
o. Symons by Dayton Superior; Resi-Chem Clear.
p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.8 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 and ACI 350R-06.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Ground Granulated Blast-Furnace Slag: 35 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.9 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 5000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.40.
3. Air Content: 6 percent, plus or minus 1.0 percent .
4. Minimum Cement Content Per Cubic Yard: 658 pounds
5. Weight: 145 pounds per cubic foot

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Construct forms tight enough to prevent loss of concrete mortar.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

E. Chamfer exterior corners and edges of permanently exposed concrete.

F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

G. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

H. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

3.3 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect/Engineer.

1. Form keyed joints as indicated. Embed keys at least 1-1/2 inch into concrete.
2. Space vertical joints in walls as indicated.

C. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated.

D. Horizontal joints are not permitted in foundations and walls.

3.4 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect/Engineer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

3.6 FINISHING FORMED SURFACES

A. Formed Finish: See landscape plans for types and locations of finishes.

1. Apply to concrete surfaces as indicated on the contract documents.

3.7 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

C. Cure concrete according to ACI 308.1.

3.8 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect/Engineer. Remove and replace concrete that cannot be repaired and patched to Architect/Engineer's approval.

3.9 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:

1. Steel reinforcement placement.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

11. Test results shall be reported in writing to Architect/Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect/Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect/Engineer.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033001

SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 2 of the Washington Suburban Sanitary Commission (WSSC) General Conditions and Standard Specifications dated 2009 and all approved addenda, except Method of Measurement and Basis of Payment.

C. Washington Suburban Sanitary Commission SEP General Conditions and Standard Specifications dated 2009 and all approved addenda, except Method of Measurement and Basis of Payment.

D. Washington Suburban Sanitary Commission Standard Details.

E. WSSC approved SEP Plans and Site Utility Plans and respective permits

1.2 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for combined water service and fire-service mains.

1.3 DEFINITIONS

A. EPDM: Ethylene propylene diene terpolymer rubber.

B. LLDPE: Linear, low-density polyethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by College or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Architect/Engineer and College's Representative no fewer than 14 days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Architect/Engineer's written permission.

1.8 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.2 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A 674 or AWWA C105.
2. Form: Sheet or tube.
3. Material: LLDPE film of 0.008-inch minimum thickness, or high-density, crosslaminated PE film of 0.004-inch minimum thickness.
4. Color: Black.

2.3 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include those specified in WSSC Specification Section 02510.

2. Nonrising-Stem, Resilient-Seated Gate Valves:

a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 200 psig.
3) End Connections: Mechanical joint.
4) Interior Coating: Complying with AWWA C550.

2.4 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include those specified in WSSC Specification Section 02510.

2. Description: Sleeve and valve compatible with drilling machine.

a. Standard: MSS SP-60.
b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WSSC WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.5 FIRE HYDRANTS

A. Fire Hydrants:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include those specified in WSSC Specification Section 02510.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" and WSSC specifications for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 shall be any of the following:

1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.

3.4 PIPING INSTALLATION

A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

C. Comply with NFPA 24 for fire-service-main piping materials and installation.

1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.

D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
2. Bury piping with depth of cover over top at least 48 inches

E. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

F. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.5 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

3.7 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position in accordance with WSSC specifications and standard details.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

3.8 CONNECTIONS

A. Connect water-distribution piping to utility water main, existing water main as indicated.

3.9 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Comply with WSSC Specification Section 02510.

C. Prepare reports of testing activities.

3.10 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in the WSSC Specifications.

3.11 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by WSSC Specification Section 02511.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

A. Washington Suburban Sanitary Commission (WSSC) SEP General Conditions and Standard Specifications dated 2009 and all approved addenda, except Method of Measurement and Basis of Payment.

B. WSSC Approved SEP Plans and associated permit requirements.

C. Washington Suburban Sanitary Commission Standard Details.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Cleanouts.
3. Manholes.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Expansion joints and deflection fittings.
2. Backwater valves.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

E. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by College or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect/Engineer and College's Representative no fewer than 14 days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect/Engineer and College's Representative written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35 PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

2.2 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: Comply with WSSC Standard Details.
2. Diameter: 48 inches minimum unless otherwise indicated.

B. Manhole Frames and Covers:

1. Description: Comply with WSSC Standard Details.

2.3 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type I and II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: Comply with WSSC Specification Section 03300.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

    a. Invert Slope: Comply with WSSC Standard Details.

2. Benches: Concrete, sloped to drain into channel.

    a. Slope: Comply with WSSC Standard Details

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping with 36-inch minimum cover unless otherwise indicated.
3. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:
   1. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

   1. Comply with WSSC Standard Specification Section 02530.

3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

   1. Abandon per WSSC Standard Details.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

   1. Remove manhole and close open ends of remaining piping.
   2. Abandon per WSSC Standard Details.

C. Backfill to grade according to Division 31 Section "Earth Moving" and WSSC Specifications.

3.8 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

   1. Use detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Conduct Mandrel Test in accordance with WSSC Specification Section 02530.
3. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    c. Infiltration: Water leakage into piping.
    d. Exfiltration: Water leakage from or around piping.

4. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
5. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Submit separate report for each test.

4. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Option: Test plastic gravity sewer piping according to ASTM F 1417.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 221313

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities and abandoning site utilities in place.
7. Temporary erosion- and sedimentation-control measures.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
2. Division 01 Section "Execution" for field engineering and surveying.
3. Division 01 Section(s) "Construction Waste Management and Disposal.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain College's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from College and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by College or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining College's property will be obtained by College before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect/Engineer.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on College's premises where indicated.

D. Utility Locator Service: In accordance with Montgomery College’s General Conditions of the Contract.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.

6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to College.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to the approved erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Division 01 and the approved Forest Conservation Plans.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect/Engineer.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by College or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect/Engineer and College's Representative not less than 14 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect/Engineer's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is included in Division 33 Sections.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Use only hand methods for grubbing within protection zones.
3. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off College's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for walks, pavements, turf and grasses and plants.
2. Excavating and backfilling for structures.
3. Subbase course for concrete walks and pavements.
4. Subbase course and base course for asphalt paving.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation" for recording pre-excavation and earth moving progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
3. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
4. Division 32 Section "Lawns, Grasses and Meadows" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
5. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by College's Representative.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by College's Representative.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1/2 cu. yd. for bulk excavation and for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Rock shall be defined as those materials that cannot be excavated with a Caterpillar Model No. 345 L track type hydraulic excavator, weighing not less than 99,000 lbs, equipped with a 30-inch wide short-tip radius rock bucket, rated not less than 345 hp flywheel power with a bucket-digging force of not less than 39,000 lbs or equivalent machinery.
2. Bulk Excavation: Rock shall be defined as those natural materials which cannot be excavated in an open excavation with a Caterpillar Model D-8, heavy duty track –type tractor, weighted at not less than 285 hp flywheel and equipped with a single-shank hydraulic ripper, capable of exerting not less than 45,000 lbs breakout force, or equivalent machinery.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches.
2. Warning Tape: 12 inches long; of each color.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

E. Blasting Plan approved by the authorities having jurisdiction.

F. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.

C. Seismographic monitoring during blasting operations

D. Preexcavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from College and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by College or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining College's property will be obtained by College before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect/Engineer.

C. Utility Locator Service: In accordance with Montgomery College’s General Conditions of the Contract.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section "Temporary Facilities and Controls", Division 31 Section "Site Clearing," are in place.

E. Do not commence earth moving operations until plant-protection measures specified in Temporary Tree and Plant Protection are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Fill and Pavement Subgrades Materials: Engineering fill below the top 12-inches of subgrade level shall consist of soils classified as ML, SM or more granular per ASTM D-2487 with a Liquid Limit of less than 40 and a Plasticity Index not to exceed 12 and compacted to at least 95 percent of the maximum dry densisty per AASHTO T99 Method C. Fill in the top 12-inches below the roadway subgrade levels should be classified as ML or more granular with a Liquid Limit less than 40 and a Plasticity Index less than 12 and a maximum dry density of 105 pcf. The top 12-inches shall be compacted to at least 100 percent of the maximum dry density per AASHTO T99 Method C. All structural fills should be placed in loose lifts not to exceed 8 inches.a maximum dry densit of Soil Classification Groups GW, GP, GM, SW, SP, SM, GC, SC, ML according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups not meeting the criteria for Fill and Pavement Subgrade Materials.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C 33; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state. complying with Maryland Pond 378 Standards and Specifications.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288:

1. MDSHA Class PE Type 1 Nonwoven.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288:

1. MDSHA Class SE Woven.

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

1. Perform blasting without damaging adjacent structures, property, or site improvements.
2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Division 01 and Approved Forest Conservation Plans.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: As indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection" and approved Forest Conservation Plans.

3.8 SUBGRADE INSPECTION

A. Notify Architect/Engineer when excavations have reached required subgrade.

B. If Contactor's geotechnical testing agency determines that unsatisfactory soil is present, Contractor's geotechnical testing agency is to provide recommendations to the College's Representative, Architect/Engineer on how to proceed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 10tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Contractor's Testing Agency, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Montgomery College's General Conditions of the Contract.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect/Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi , may be used when approved by Architect/Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect/Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Comply with WSSC Standard Specifications and Standard Details for water and sanitary sewer construction.

C. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

D. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.

2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to AASTHO T99 Method C:

1. Under pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 100 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch .
2. Walks: Plus or minus 1 inch .
3. Pavements: Plus or minus 1/2 inch .

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 100 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 100 percent of maximum dry unit weight according to AASTHO T99 Method C.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect/Engineer.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect/Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off College’s property.

END OF SECTION 312000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Contractor shall comply with the latest edition of Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials (January 2008) and all approved addenda, except Method of Measurement and Basis of Payment.

C. Montgomery County Department of Permitting Services approved Street Grade Establishment Plan, Storm Drain and Paving Plan and associated permit.

1.2 SUMMARY

A. Section Includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Pavement-marking paint.

B. Related Sections:

1. Division 31 section “Earth Moving” for aggregate subbase and base course and for aggregate pavement shoulders.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
2. Job-Mix Designs: For each job mix proposed for the Work.

B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Samples: For each paving fabric, 12 by 12 inches minimum.

D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:

1. Each paving fabric, 12 by 12 inches minimum.
2. Each type and color of preformed traffic-calming device.
3. Each pattern and color of imprinted asphalt and precut marking material.

E. Qualification Data: For qualified manufacturer and Installer.

F. Material Certificates: For each paving material, from manufacturer.

G. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located

B. Installer Qualifications: Imprinted-asphalt manufacturer's authorized installer who is trained and approved for installation of imprinted asphalt required for this Project.

C. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

D. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Standard Specifications for Materials and Construction of The Maryland State Highway Administration for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

E. Preinstallation Conference: Conduct conference at Project site .

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review condition of subgrade and preparatory work.
c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials and 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: In accordance with MDSHA Standards and Specifications.

C. Fine Aggregate: In accordance with MDSHA Standards and Specifications.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: In accordance with MDSHA Standards and Specifications.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: In accordance with MDSHA Standards and Specifications.

B. Asphalt Cement: In accordance with MDSHA Standards and Specifications.

C. Prime Coat: Asphalt emulsion prime coat complying with Maryland DOT requirements.

D. Tack Coat: In accordance with MDSHA Standards and Specifications.

E. Water: Potable.

F. Undersealing Asphalt: ASTM D 3141, pumping consistency.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Sand: In accordance with MDSHA Standards and Specifications.

C. Joint Sealant: In accordance with MDSHA Standards and Specifications.

D. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type F; colors complying with FS TT-P-1952.

1. Color: As indicated.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: 19mm Superpave
3. Surface Course: 9.5mm Superpave

B. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect/Engineer, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.

3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.

3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch

2. Surface Course: 1/8 inch
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect/Engineer.

B. Allow paving to age for days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials, July 2008 and all approved addenda, except Method of Measurement and Basis of Payment.

1.2 SUMMARY

A. Section Includes:

1. Driveways.
2. Curbs and gutters.
3. Walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

E. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.

7. Bonding agent or epoxy adhesive.
8. Joint fillers.

F. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

G. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

C. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

D. ACI Publications: Comply with ACI 301 unless otherwise indicated.

E. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete paving subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials and 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

D. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

F. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

H. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

I. Plain-Steel Wire: ASTM A 82/A 82M.

J. Deformed-Steel Wire: ASTM A 496/A 496M.

K. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray portland cement Type II. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class C or Class F.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IP, portland-pozzolan cement.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source[with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.
b. BASF Construction Chemicals, LLC; Confilm.
c. ChemMasters; Spray-Film.
d. Conspec by Dayton Superior; Aquafilm.
e. Dayton Superior Corporation; Sure Film (J-74).
f. Edoco by Dayton Superior; BurkeFilm.
g. Euclid Chemical Company (The), an RPM company; Eucobar.
h. Kaufman Products, Inc.; VaporAid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation, Inc.; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.

E. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; A-H Curing Compound #2 WP WB.
b. ChemMasters; Safe-Cure 2000.
c. Conspec by Dayton Superior; DSSCC White Resin Cure.
d. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).
e. Edoco by Dayton Superior; Resin Emulsion Cure V.O.C. (Type II).
f. Euclid Chemical Company (The), an RPM company; Kurez VOX White Pigmented.
g. Kaufman Products, Inc.; Thinfilm 450.
h. Lambert Corporation; AQUA KURE - WHITE.
i. L&M Construction Chemicals, Inc.; L&M CURE R-2
j. Meadows, W. R., Inc.; 1100-WHITE SERIES.
k. SpecChem, LLC; PaveCure Rez White.
l. Symons by Dayton Superior; Resi-Chem White.
m. Vexcon Chemicals Inc.; Certi-Vex Enviocure White 100.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, non-load bearing and Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): MDSHA Mix 3 per Section 901A

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture, high-range, water-reducing admixture, high-range, water-reducing and retarding admixture, plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals and as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms[, steel reinforcement,] and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect/Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect/Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect/Engineer.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect/Engineer.

B. Drill test cores, where directed by Architect/Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Contractor shall comply with the latest edition of Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials (January 2008) and all approved addenda, except Method of Measurement and Basis of Payment.

1.2 SUMMARY

A. Section includes painted markings applied to asphalt pavement.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to marking pavement including, but not limited to, the following:

a. Pavement aging period before application of pavement markings.
b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include technical data and tested physical and performance properties.

B. Shop Drawings: For pavement markings.

1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Samples: For each exposed product and for each color and texture specified; on rigid backing, 8 inches square.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Standard Specifications for Construction and Materials (January 2008) of State Highway Administration for pavement-marking work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials and 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with Maryland State Highway Standards Specifications and requirements,

2.2 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint:

1. Color: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect/Engineer.

B. Allow paving to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.

2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal or as specified in the Maryland State Highway Standard Specifications..

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

SECTION 323223 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes single depth segmental retaining walls with and without soil reinforcement.

B. Related Sections:

1. Section 033001 "Cast-in-Place Concrete for Site Retaining Walls" for segmental retaining wall footings.
2. Section 312000 "Earth Moving" for excavation for segmental retaining walls.

1.3 PERFORMANCE REQUIREMENTS

A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
2. Superimposed loads (surcharge) indicated on Drawings.

1.4 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For concrete units.

C. Samples for Verification: For each color and texture of concrete unit required. Submit sections of units not less than 3 inches square.

1. Include one full-size unit for each type of concrete unit required.

D. Delegated-Design Submittal: For segmental retaining walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer and testing agency.

B. Product Certificates: For segmental retaining wall units and soil reinforcement, from manufacturer.

1. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
2. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for segmental retaining wall units and soil reinforcement.

1. Include test data for freeze-thaw durability of segmental retaining wall units.
2. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
3. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

D. Preconstruction test reports.

E. Source quality-control reports.

F. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall approximately 72 inches long by not less than 36 inches high above finished grade at front of wall.

a. Include typical soil reinforcement.
b. Include typical base and cap or finished top construction.

c. Include backfill to typical finished grades at both sides of wall.
d. Include typical end construction at one end of mockup.
e. Include 36-inch return at 1 end of mockup, with typical corner construction.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to segmental retaining walls including, but not limited to, the following:

a. Structural load limitations.
b. Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Field quality-control procedures.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F, and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, licensees of one of the following:

a. Allan Block Corporation.
b. Anchor Wall Systems, Inc.
c. Keystone Retaining Wall Systems, Inc.; a Contech company.
d. Tensar Earth Technologies, Inc.
e. Versa-Lok Retaining Wall Systems; a division of Kiltie Corporation.

2. Provide units that comply with requirements for freeze-thaw durability.
3. Provide units that interlock with courses above and below by means of integral lugs or lips, pins, or clips.

B. Color: As selected by Architect/Engineer from manufacturer's full range.

C. Shape and Texture: Provide units of basic shape and dimensions indicated with machine-split textured exposed faces.

D. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.

E. Shape and Texture: Provide units of any basic shape and dimensions that will produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with machine-split textured, flat exposed face.

F. Batter: Provide units that offset from course below by at least ¾".

G. Cap Units: Provide cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.

H. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces as indicated.

2.2 INSTALLATION MATERIALS

A. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

B. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

C. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

D. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for base material.

1. Leveling Course: Lean concrete with a compressive strength of not more than 500 psi.

E. Drainage Fill: Comply with requirements in Section 334600 "Subdrainage."

F. Reinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

G. Reinforced-Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 sieve, 0 to 60 percent passing No. 40 sieve, 0 to 35 percent passing No. 200 sieve, and with fine fraction having a plasticity index of less than 20.

H. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

I. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb; ASTM D 4632.
3. Minimum Weight: 4 oz./sq. yd..

J. Subdrainage Pipe and Filter Fabric: Comply with requirements in Section 334600 "Subdrainage."

K. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as follows:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide a product in accordance with the selected wall manufacturer's requirements.

2.3 SOURCE QUALITY CONTROL

A. Direct manufacturer to test and inspect each roll of soil reinforcement at the factory for minimum average roll values for geosynthetic index property tests, including the following:

   1. Weight.
   2. Roll size.
   3. Grab or single-rib strength.
   4. Aperture opening.
   5. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

   1. Lay units in running bond.
   2. Form corners and ends by using special units.

B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

   1. Leveling Course: Place unreinforced lean concrete over leveling base 1 to 2 inches thick. Compact and screed concrete to a smooth, level surface.

C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

   1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

   1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
   2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.

3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
4. For units with pins, install pins and align units.
5. For units with clips, install clips and align units.

E. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 312000 "Earth Moving" NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.
2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

    a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
    b. In areas where fill height exceeds 15 feet compact reinforced-soil fill that will be more than 15 feet below finished grade to not less than 98 percent maximum dry unit weight according to ASTM D 698.
    c. In areas where fill height exceeds 30 feet compact reinforced-soil fill that will be more than 30 feet below finished grade to not less than 100 percent maximum dry unit weight according to ASTM D 698.

3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

D. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 inches wide behind drainage geotextile to within 12 inches of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

E. Place a layer of drainage fill at least 12 inches wide behind wall to within 12 inches of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

F. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.

G. Place impervious fill over top edge of drainage fill layer.

H. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.

I. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
3. Do not dump fill material directly from trucks onto geosynthetics.
4. Place at least 6 inches of fill over reinforcement before compacting with tracked vehicles or 4 inches before compacting with rubber-tired vehicles.
5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3 inches maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

1. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 150 feet or less of segmental retaining wall length.
2. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 24 inches of fill depth and each 50 feet or less of segmental retaining wall length.

3.6 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect/Engineer approves methods and results.
2. Segmental retaining walls that do not match approved Samples and mockups.
3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 323223

SECTION 329210 – LAWNS, GRASSES AND MEADOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Sodding.
4. Low mow mix, meadow grasses and wildflowers.

B. Related Sections:

1. Division 01 Section "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
3. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
4. Division 32 Section "Plants" for planting.

1.3 DESCRIPTION

A. Seeding: This work shall consist of soil preparation, seeding, addition of soil amendments (as determined by the soil test results), mulching, overseeding, and mowing all areas designated for turf establishment as specified in the Contract Documents or as directed by the College or College’s representative.

B. Sodding: This work shall consist of soil preparation, addition of soil amendments (as determined by the soil test results), watering, and placing grass sod on prepared areas, as specified in the Contract Documents or as directed by the College or College’s representative.

1.4 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

D. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

E. Planting Soil: Material consisting of standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or, manufactured topsoil; which is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

F. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

G. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

H. Surface Soil: Whatever soil is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Submit proposed seed mixture for approval.

C. Certification of seed: Submit Manufacturer's certificates of purity and guarantees of germination for each seed mixture in accordance with Maryland Seed Law. Certification of seed shall include the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging. Certifications include, but are not limited to:

1. Certification of each seed mixture for turfgrass sod, including identification of source and name and telephone number of supplier.
2. Certification of each seed mixture for turfgrass hydroseeding
3. Certification of each seed mixture for turfgrass seeding
4. Certification of each seed mixture for low mow mixes, meadow grasses and wildflowers

D. Qualification Data: For qualified landscape Installer.

E. Product certificates: For soil amendments and fertilizers, from manufacturer.

F. Soils tests, analysis and recommendations.

G. Maintenance Instructions: Recommended procedures to be established by College for maintenance of turf, low mow grasses and meadows during a calendar year. Submit before expiration of required initial maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf and meadow establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years experience in turf installation in addition to requirements in Division 1 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

    a. Landscape Industry Certified Technician – Exterior.
    b. Landscape Industry Certified Lawn Care Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory such as a state laboratory, commercial laboratory or university laboratory, recognized by the State, with the experience and capability to conduct the testing indicated and that specializes in the types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. The soil-testing laboratory shall oversee soil sampling, with representative samples taken from varied locations for each soil to be used or amended for planting purposes. Perform soil tests for all soil to be used from both on-site and off-site sources.
2. Report suitability of tested soil for plant growth.

    a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

D. Preinstallaton Conference: conduct conference at Project Site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable. Store packaged materials in a manner that will prevent damage or intrusion of foreign matter. Any material that becomes contaminated will be removed from the job site.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, lime and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Seed

a. Spring Planting: March 01 to May 15
b. Fall Planting: August 15 to October 15

2. Sod

a. Spring Planting: March 01 to June 15
b. Fall Planting: August 15 to October 15

3. Low Mow and Meadow

a. Spring Planting: March 15 to April 30
b. Fall Planting: September 15 to October 31

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions

1.9 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by College, or incidents that are beyond Contractor’s control.
b. Structural failures including plantings falling or blowing over.

2. Warranty Periods from Date of Planting Completion:

a. Seeded Turf: 12 months, or completion of a single growing season, whichever is greater.
b. Sodded Turf: 12 months, or completion of a single growing season, whichever is greater.
c. Seeded Low Mow or Meadow: 12 months, or completion of a single growing season, whichever is greater.

1.10 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: From date of installation to end of Warranty Period.
2. Sodded Turf: From date of installation to end of Warranty Period.

B. Initial Low Mow or Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than the following:

1. Seeded Low Mow or Meadow: From date of installation to end of Warranty Period and completion of Year 1 maintenance as described in Section 3.11.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances. It shall be mixed in the proportion shown and test results certifying no more than .02% weed seed and 85% minimum germination. Approved varieties shall be selected from “Recommended Turfgrass cultivars for Professional Seed Mixtures,” University of Maryland Turfgrass Technical Update TT-77, most recent edition. A copy of this publication can be obtained by visiting the Maryland Turfgrass Council website http://www.mdturfcouncil.org or by calling them at 410-836-2876.

B. Seed Species: State-certified seed of grass species as follows:

1. Sun and Partial Shade: Proportioned by weight as follows:

a. 80-95% Certified Tall Fescue
b. 5-10% Certified Kentucky Bluegrass
c. 0-10% Certified Perennial Ryegrass *

*Note: The routine inclusion of perennial ryegrass is not recommended, but may be added to the mixture when the seeding site is at high risk for soil erosion or when cool temperatures may hinder establishment of tall fescue and Kentucky bluegrass. Two cultivars of tall fescue and one cultivar of Kentucky bluegrass may be used, but the inclusion of three or more tall fescue cultivars is recommended. The seeding rate of this mixture shall be 7.0 to 8.0 lbs. P.L.S. per 1000 ft^2.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Maryland Certified (labeled), inspected and approved by the Maryland Department of Agriculture, complying with Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species:

1. Sod shall be a 90/10 mix with 90% of the mix consisting of a blend of at least three turf type tall fescues, and at least 10% Bluegrass. Approved varieties shall be selected "Recommended Turfgrass cultivars for Professional Seed Mixtures," University of Maryland Turfgrass Technical Update TT-77 most recent edition. A copy of this publication can be obtained by visiting the Maryland Turfgrass Council website http://www.mdturfcouncil.org or by calling them at 410-836-2876.

    a. Thickness of Cut: The thickness of the roots and soil should be ½" to ¾".
    b. Pad Size: Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be 5%. Broken pads and torn or uneven ends will not be acceptable.
    c. Strength of Sod Sections: Under ideal conditions, standard size sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically from a firm grasp on the upper 10% of the section **without the use of netting**. NOTE: Younger tall fescue will not be strong enough to pass this test but is still okay to use.
    d. Sod Viability: Sod shall not be harvested or transplanted under drought conditions.

2.3 MEADOW GRASSES AND WILDFLOWERS

A. Wildflower and Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as follows:

1. See Plans for mix of wildflower and native grass species.

B. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.4 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.
2. Provide lime in form of ground dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content less than or equal to 30 percent by weight; 98 percent passing through 1-inch sieve; soluble salt content of less than 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.7 SUBSOILS

A. Subsoils shall contain a maximum volume of 25% of rocks or other materials larger than 0.25 inches in diameter, and shall contain no rocks or other materials larger than 5.0 inches in diameter. The depth of the subsoil layer that lies upon rock or other materials which do not themselves constitute subsoil shall be at least 6.0 inches deep. When the subsoil layer is less than 6.0 inches deep, either topsoil or additional subsoil shall be moved to the site and spread in a layer so that the base of subsoil upon which the final topsoil layer will be spread is at least 6.0 inches deep. Subsoils shall not contain any chemicals or other materials in concentrations which may be toxic to the growth of turfgrass seedlings.

B. Test subsoils for pH, soluble salts, phosphorus and potassium. Subsoils shall not have acidity below pH 5.5 or above pH 7.5. Subsoils with pH 6.5 is ideal. Subsoils shall not be deficient in phosphorus or potassium based on turfgrass requirements. If deficient, amend subsoils in accordance with recommendations obtained from the soil testing laboratory.

2.8 PLANTING SOILS

A. Planting Soils are amended existing stockpiled ASTM D 5268 topsoil, amended existing in-place soil, or amended soil from an off-site source that has been spread to finish grade, will support plant growth, and meets the following requirements. The soil shall closely match the mechanical analysis (percentage sand, silt and clay) of the existing subsoil. Soil shall be free of cinders, stones, slag, coarse fragments, gravel, sticks, trash, roots, plants, sod, clods, clay lumps, pockets of coarse sand and other debris over 3/4" in any dimension. Soil will be to a depth of 12” for landscape areas, 6” for lawn areas, and 18” for individual trees and shrubs. It must also be free of plants or plant parts of Bermuda grass, Quack grass, Johnson grass, Nutsedge, Poison Ivy, Phragmites, Canada thistle, or any noxious weeds. The soil shall contain no paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, or other substances harmful to plant growth. If the existing native subsoil is a bank run gravel, the topsoil or landscape bedding soil shall be a sandy loam.

B. Amend soils based on soil test results in accordance with soil testing lab recommendations for the type of plant material used in each respective planting area. Wherever practicable, Contractor shall amend native, on-site soils as required to create planting soils.

1. Soil for turf areas:

    a. Topsoil shall be of a nature and quality sufficient to establish and support the growth of turfgrass. To a depth of 4.0 inches below the soil surface, topsoil shall contain a maximum volume of 15% of rocks or other stony material larger than 0.25 inches in diameter; no rocks or other stony material larger than 3/4 inches in diameter; a minimum organic matter content of 4.0%; and no soil sterilants, herbicides, or other materials harmful to germinating grasses.
    b. The pH shall be between 6.0-7.0.
    c. The acceptable amount of Magnesium shall be 35 pounds per acre; Phosphorus shall be 100 pounds per acre; Potassium shall be 85 pounds per acre, and Nitrogen shall be a minimum of 50 pounds per acre.
    d. Soluble salts shall not exceed 3 mmhos/cm. Calcium levels shall not exceed 2000 parts per million.
    e. Organic Matter shall be greater than four percent.

2. Soil for Landscaping areas

    a. The pH shall be based on the specific plant requirements but will be within the range of 5.5-6.5.
    b. The acceptable amount of Magnesium shall be 71-124 pounds per acre; Phosphorus shall be 62-102 pounds per acre; Potassium shall be 85-160 pounds per acre, and Nitrogen shall be a minimum of 50 pounds per acre.
    c. Soluble salts shall not exceed 4mmhos/cm, Calcium levels shall not exceed 2,000 parts per million.
    d. Organic Matter shall be greater than five percent.

2.9 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, bright, small grain type straw. Straw shall be free of rot and noxious weed seeds. Apply ½"- ¾" thick layer or 60-80 bales/acre.

B. Hydro mulch: Wood cellulose applied at a net dry weight of 750 pounds per acre. See LCA, Landscape Specification Guidelines, Seeding and Sodding specifications, Section 5.3 Mulching Materials, for detailed specifications.

2.10 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.11 HERBICIDES

A. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

B. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 SOIL TESTING

A. All soil testing shall be done at the Contractor's expense. Soil tests shall be conducted by a state laboratory, university laboratory or recognized commercial laboratory. Each sample shall be extracted from a six-inch deep core and prepared in accordance with recommendations of the soil-testing laboratory.

B. Each soil test shall determine soil texture (mechanical analysis), pH, magnesium, phosphorus, potassium, soluble salts, total calcium, nitrogen, and percent organic matter. If the soil is sandy, it shall also be tested for boron. Soil test results shall include laboratory recommendations for soil amendments to correct deficiencies and accomplish planting objectives. Follow recommendation of Landscape Specification Guidelines, latest edition, Landscape Contractor's Association of Maryland, Virginia, and The District of Columbia, Seeding and Sodding Section for optimum plant growth and provide course of action based on their recommendation. The Contractor shall submit plans with the soil test results showing the locations of all soil tests. Incomplete test results and plans will be rejected, and shall be redone at the Contractor's expense.

C. For all new soils provided from off-site sources, obtain one soil test for each soil source per 500 cubic yards of soil and submit soil test results and soil amendment recommendations to College or College's representative for review and acceptance prior to distributing and amending soil.

D. For all existing stockpiled topsoil to be redistributed on site, obtain one soil test per 500 cubic yards of soil prior to application. Submit soil test results and soil amendment recommendations to College or College's representative for review and acceptance prior to redistributing and amending soil.

E. Where paving and base materials have been removed and the area is to be re-established with lawn or planting, obtain one composite soil test per 10,000 square feet of subsoil material, or at least one composite test for each separate excavated area. Each composite soil test shall consist of no less than five one-half cup samples taken at random from each sampling area. Each sample shall be taken from a six-inch deep core. The five or more samples shall be mixed together to form a composite sample, from which a pint sample shall be extracted, air-dried and tested. Submit soil test results and subsoil amendment recommendations to College or College's representative for review and approval subsoil amendment recommendations prior to filling the area with soil.

F. For existing soil to remain in place and be amended for landscape areas, submit one composite soil test for each isolated bed area (separated from other beds by paving). For existing soil to remain in place and be amended for lawn areas, submit one composite soil test per 20,000 square feet. Composite tests for planting areas shall be mixed from a minimum of five samples as described in E above. Composite tests for lawn areas shall be mixed from a minimum of ten samples as described in E above. Submit soil test results and soil amendment recommendations to College or College's representative for review prior to amending soil.

G. Following completion of soil amendment operations and fine grading, and prior to planting, 10 additional soil samples shall be taken at random from planting and lawn areas throughout the site. The College or College's representative shall determine locations of tests. These samples shall not be composite samples and are to assure that soils have been amended properly prior to planting or installation of lawn. Submit soil test results to College or College's representative for review. If it is apparent that soils have not been amended as specified or protected from contamination, areas not in compliance with specified requirements shall be reworked and retested as required until soils meet specified requirements. All rework and retesting shall be at the Contractor's expense.

3.2 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. All areas to receive planting soil shall be free of construction debris, refuse, compressible or decayable materials, stones greater than two inches and standing water.
3. Do not mix or place soils and soil amendments in frozen, excessively dry, wet, or muddy conditions.
4. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
5. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.3 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.

2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.4 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Subsoil areas which are intended to receive topsoil shall be maintained on a true and even grade, in compliance with plans, drawings or other applicable specifications pertaining to the site, with no significant depressions or elevations. Topsoil shall not be deposited or spread over the subsoil until rough grading has been completed and all areas within the subgrade are within 2/10 of 1.0 foot (2.5 inches per foot) from the final subgrade. If the graded area develops weed or other plant growth, the plants shall be eliminated before topsoil is deposited or spread over the subsoil.

C. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches by disking, tilling, or scarifying with rototillers, disk harrows, chisel plows, rippers, or other suitable soil preparation equipment. Incorporate recommended soil amendments into top 6” of subsoil. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off College's property.

1. Wherever suitable native on-site soil is available, contractor shall amend this soil to create planting soil.
2. Thoroughly blend planting soil before spreading or spread planting soil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    b. Mix lime with dry soil before mixing fertilizer.

3. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
    b. Reduce elevation of planting soil to allow for soil thickness of sod.

D. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.

    a. Apply fertilizer directly to surface soil before loosening.

3. Remove stones larger than ¾ inch in any dimension and sticks, roots, trash, brush, wire, grade stakes and other debris that would interfere with seeding and sodding.
4. Legally dispose of waste material, including grass, vegetation, and turf, off College's property.

E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill

depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

F. For soil preparation in critical root zone areas of existing trees, all work must be done by hand with shovels and rakes, unless otherwise approved in writing by the M-NCPPC inspector.

G. Planting may be done immediately thereafter, provided the topsoil has remained in a good, friable condition and has not become muddy or hard. If it has become hard, it shall be tilled to a friable condition again before acceptance. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

H. Before planting, obtain College or College's representative acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.5 SEEDING

A. Seed shall be used within 9 months of its most recent germination test.

B. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

C. Sow seed at a total rate of 7 to 8 lb P.L.S./1000 sq. ft.

D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

E. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

F. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

G. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil, rolling thoroughly in several directions with suitable mechanical equipment.

H. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.

2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with biodegradable staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
3. On slopes greater than 1:3 or steeper staple sod at a minimum of 4 staples per square yard of sod.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow Fescue/Kentucky bluegrass to a height of 2 to 3 inches.

D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect/Engineer:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

C. Turf Grass Conditions will not be accepted if there is a poor or thin stand; improper application of sod, dead grass or sod, use of seed mixtures or sod other than approved in specifications, improper fertilizer application either uneven spreading or insufficient amounts, or failure to re-fertilize during extended acceptance, and the presence of persistent weeds established in turf areas.

3.10 MEADOW

A. Sow seed by broadcasting or drill seeding. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

2. Broadcast seeding: Broadcast seeding shall involve the use of a properly calibrated reciprocating spreader (e.g., ViconTM), or a properly calibrated rotary spreader (e.g., ScottsTM model R-8), or similar equipment which is equipped with an agitator to ensure continuous mixing. All of the grass and forb seed intended for the dry meadow seeding site shall be combined in a barrel or other suitablecontainer with one or more coarse, low density, non-toxic bulking agents such as calcined clay (Kitty LitterTM, or similar product), fine cocoa shell mulch, coarse vermiculite, or coarse perlite, and thoroughly mixed at the time of seeding. Thorough mixing and the use of one or more bulking agents is required to ensure continuous seed flow through the spreader, and to improve seed distribution by preventing seed mix segregation.

3. Broadcast seeding soil incorporation and rolling: After seeding, the seed shall be raked or dragged into the soil surface to an average depth of 0.10 to 0.25 inch. When the soil is in a loose or fluffy condition, the seedbed shall be rolled with a weighted roller, so that the grass and forb seed is firmly pressed into the soil

4. Drill seeding: Drill seeding involves the use of a drill seeder that is manufactured specifically for fluffy grass and forb seed. Suitable seeders typically include three separate seed hoppers with positive-feed mechanisms, and include Truax™ and Tye™ seeders, among others. The seed of each species to be seeded shall be obtained unmixed, and shall be sorted by size as directed by the manufacturer of the seeding equipment. All instructions provided by the manufacturer of the seeding equipment shall be strictly observed and followed by the contractor.

5. Drill seeding soil incorporation and rolling: Most suitable seeders include soil openers to ensure a seeding depth of 0.10 to 0.50 inches as well as rollers to ensure a firm seedbed. However, if the

seeding equipment is not equipped with a heavy roller, so that the soil is left in a loose or fluffy condition after seeding, the seedbed shall be rolled with a weighted roller in a separate operation, so that the grass and forb seed is firmly pressed into the soil.

B. Sow seed at rate shown on Plans.

C. Seed mulch materials. The use of straw with or without hydraulic mulch products and the use of erosion control blankets is acceptable as specified in below:

1. Seed mulches shall include straw, or straw + tackifier, or straw + hydraulic mulch (wood fiber and/or paper mulch) or erosion control blankets. The composition of straw used shall conform to Section 3.10-C-2, and its use shall conform to the specifications of Section 3.10-C-3. The composition and use of hydraulic mulch products and accessories shall conform to the specifications of Section 7.2, 7.3, 7.4 and 7.5 of the Maryland Seeding Association Guideline Specification 2005 and their use in conjunction with straw shall conform to the specifications of Section 3.10-C-3-a, b and c.

2. Straw definition and use. The use of clean straw with a low content of viable cereal grains and viable weed seed is important. Class 'AA' and Class 'A' straw are generally recommended as mulch; Class 'B' straw is not recommended. Neither Class 'C' straw nor hay shall be used as a mulch. See Section 7.6, 12.10c.2, and 12.10c.3 of the Maryland Seeding Association Guideline Specification 2005 for more information about straw and mulch application.

3. Use of straw: On level or gently rolling sites the use of straw is optional. Where soil erosion is likely, straw shall be uniformly applied over the surface of the seeded area at a rate of 1.0 to 2.0 tons per acre. The straw shall cover a minimum of 80% of the soil surface in a layer from 0.5 to 2.0 inches thick. On slopes over 4:1 in steepness, 2.0 tons of straw per acre shall be applied and secured from wind/water erosion by one of the methods described below and the seeding rate shall be adjusted as required.

a. Straw anchoring with crimper: Straw shall be secured with a mulch anchoring tool (straw crimper), by pressing the straw to a minimum average depth of 2.0 inches below the soil surface.

b. Straw anchoring with tackifier: Straw shall be secured with tackifier or mulch binder when the tackifier or mulch binder is applied over the straw in a separate operation with hydraulic seeding equipment at the minimum rate recommended by the manufacturer, so that 80+% of the straw is covered by the tackifier or mulch binder.

c. Straw anchoring with hydraulic mulch: Straw shall be secured with paper or wood fiber + paper hydraulic mulch when the mulch is applied in a separate operation over the straw with hydraulic seeding equipment at the rate of 150 lbs./acre, so that 80+% of the straw is covered by the hydraulic mulch. This method is not recommended when the dry meadow seed mix contains native wildflowers (forbs). However; if this method is used, the seeding rate of each forb species included in the seed mix shall be increased to 1.5 times (1.5x) the recommended seeding rate.

D. Irrigation during germination: For optimum germination of meadows it is recommended that these sites be seeded when a minimum of 0.25 inch of natural rainfall or irrigation will be received within 10 days after seeding. If sufficient natural rainfall is not received within 10 days, it shall be the responsibility of the College, general contractor, or seeding contractor (as a special clause of the contract) to irrigate the new seeding with a minimum of 0.25 inch of water, or so that water penetrates the soil to a uniform minimum depth of 4.0 inches. It is recommended that when natural rainfall is not able to provide the water needs of germinating seeds, irrigation should be supplied as needed to ensure that the upper 0.5 inches of the soil surface does not dry to the extent that seedlings are allowed to wilt or die.

3.11 MEADOW MAINTENANCE

A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Multi-year Maintenance Plan. Contractor shall provide Year 1 maintenance. College shall provide Years 2, 3, and beyond. Contractor shall submit specific maintenance recommendations to College for Years 2, 3, and beyond.

1. Year 1 Maintenance
   a. Mow meadow three (3) times per year (mid-June, mid-July, and mid-August) to minimize weed seed formation.
   b. Keep weeds mowed back to six (6) inches tall. When weeds grow to twelve (12) inches tall, mow back to six inches. Do not wait until weeds are taller than twelve inches, as mowed material can smother small seedlings.
   c. Use a flail type mower if possible, as it shreds the vegetation and prevents clumping.
   d. Do not mow when soils or plants are wet.
   e. Collect and dispose of trash and other litter before each mowing.

2. Year 2 Maintenance
   a. Mow meadow two (2) times per year (mid-June and mid-August) to minimize weed seed formation.
   b. Keep weeds mowed back to twelve (12) inches tall. Biennial weeds should be mowed when in full bloom, but before setting seed.
   c. Use a flail type mower if possible, as it shreds the vegetation and prevents clumping.
   d. Do not mow when soils or plants are wet.
   e. Collect and dispose of trash and other litter before each mowing.
   f. Spot weed problem weeds by gentle pulling or treatment by hand with glyphosate. Do not spray glyphosate, as the drift can kill large patches of desirable plants.
   g. Over the course of the summer, if there is no significant rain for four (4) weeks, provide irrigation to deliver one (1) inch of water per week in a single application.

3. Year 3 Maintenance
   a. Mow meadow in mid spring (between March 15 and April 1) to a height of two (2) inches.
   b. Rake out and compost the mowed material from the meadow area.
   c. Use a flail type mower if possible, as it shreds the vegetation and prevents clumping.
   d. Do not mow when soils or plants are wet.
   e. Collect and dispose of trash and other litter before mowing.
   f. Continue to spot weed as described in Year 2.
   g. Over the course of the summer, if there is no significant rain for four (4) weeks, provide irrigation to deliver one (1) inch of water per week in a single application.

4. Years Beyond Maintenance
   a. Mow meadow to a height of six (6) to ten (10) inches between late November and early December.

b. Disperse the mowed material throughout the meadow area.
c. Use a flail type mower if possible, as it shreds the vegetation and prevents clumping.
d. Do not mow when soils or plants are wet.
e. Collect and dispose of trash and other litter before mowing.
f. Continue to spot weed as described in Year 2.
g. Over the course of the summer in Years 4 and 5, if there is no significant rain for four (4) weeks, provide irrigation to deliver one (1) inch of water per week in a single application.

C. Irrigation during establishment: The soil of the seedbed should be maintained in a moist condition favorable for the establishment dry meadow species for a minimum of 45 days after seeding. Occasional irrigation after that period, particularly in the late Spring or early Summer following a spring seeding, may be necessary for the survival of seedlings. It shall be the responsibility of the seeding contractor to provide written notice and verbal explanation of the irrigation needs of the meadow to the College, general contractor, or other parties responsible for maintaining newly seeded meadow; Follow Section 3.10 D for irrigation recommendations.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with College's operations and others in proximity to the Work. Notify College before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after establishment period.

3.14 TEMPORARY SEEDING

A. Preparation:
1. Loosen top 2 inches of seedbed.
2. Apply lime and fertilizer at rates specified by soil testing laboratory.

B. Seed Application: Follow application for permanent seeding.

C. Mulch Application: Follow application for permanent mulching.

3.1 TIME RESTRICTIONS

A. When permanent seeding or sodding is specified or directed, and is not allowed because of time restrictions specified above, utilize one or more of following methods to prevent erosion and sedimentation until permanent seeding or sodding is allowed.

1. Place and anchor straw mulch or wood chips.
2. Apply temporary seeding and mulch.
3. Prepare soil as for permanent seeding and then mulch as specified herein; overseed during next seasonal seeding period.
4. Provide other erosion control measures acceptable to Engineer.
5. Remove straw or wood chips used as temporary mulch or work into subsoil minimum depth of 6 inches before initiation of permanent seeding or sodding application.

END OF SECTION 02920

SECTION 329310 – PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.

B. Related Sections:

1. Division 01 Section "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
3. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
4. Division 32 Section "Lawns, Grasses and Meadows" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

D. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

H. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

I. Planting Area: Areas to be planted.

J. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

K. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

M. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.
3. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Organic Mulch: 1-pint volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.

Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

2. Mineral Mulch: 2 lb of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and makeup of the material.

C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

D. Material Test Reports: For existing native surface topsoil and imported or manufactured topsoil.

E. Maintenance Instructions: Recommended procedures to be established by College for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation in addition to requirements in Division 1 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

   Certified Landscape Technician - Exterior, with installation or maintenance specialty area(s), designated CLT-Exterior.
   Certified Ornamental Landscape Professional, designated COLP.

5. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for plant growth.

   State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

E. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

F. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Do not remove container-grown stock from containers before time of planting.
2. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

C. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by College, or incidents that are beyond Contractor's control.
Structural failures including plantings falling or blowing over.

2. Warranty Periods from Date of Planting Completion:

Trees, Shrubs, Vines, and Ornamental Grasses: 12 months, or completion of a single complete growing season, whichever is greater.
Ground Covers, Biennials, Perennials, and Other Plants: 12 months, or completion of a single complete growing season, whichever is greater.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period for Trees and Shrubs: From date of installation to end of Warranty Period.
2. Maintenance Period for Ground Cover and Other Plants: From date of installation to end of Warranty Period.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect/Engineer, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

E. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
2. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content less than or equal to 30 percent by weight; 98 percent passing through 1-inch sieve; soluble salt content of less than 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 10 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

E. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

F. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

2.5 PLANTING SOILS

A. Importing soils blended off0site will not be permitted, unless installer shows that native soils, either as-is or blended with soil amendments, will not conform with these specifications.

B. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Topsoil by Volume: 1:4.
2. Ratio of Loose Sphagnum Peat to Topsoil by Volume: 1:10.
3. Ratio of Loose Wood Derivatives to Topsoil by Volume: 1:10.
4. Weight of Lime per 1000 Sq. Ft.: Per soil testing lab recommendations.
5. Weight of Iron Sulfate per 1000 Sq. Ft: Per soil testing lab recommendations.
6. Weight of Agricultural Gypsum per 1000 Sq. Ft.: Per soil testing lab recommendations.
7. Volume of Sand per 1000 Sq. Ft.: Per soil testing lab recommendations.
8. Weight of Bonemeal per 1000 Sq. Ft.: Per soil testing lab recommendations.
9. Weight of Superphosphate per 1000 Sq. Ft.: Per soil testing lab recommendations.
10. Weight of Commercial Fertilizer per 1000 Sq. Ft.: Per soil testing lab recommendations.
11. Weight of Slow-Release Fertilizer per 1000 Sq. Ft.: Per soil testing lab recommendations.

2.6 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood, well aged.
2. Color: Natural.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content less than or equal to 30 percent by weight; 98 percent passing through 1-inch sieve; soluble salt content of less than 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

2.7 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.8 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.
3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
4. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
5. Guy Cables: Five-strand, 3/16-inch-diameter, galvanized-steel cable, with zinc-coated turnbuckles, with two galvanized eyebolts.
6. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Landscape Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

3.3 PLANTING SEASONS

A. September 1 to June 15, whenever soil is not frozen or excessively wet. Do not plant oaks during fall.

3.4 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 12 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off College's property.

1. Thoroughly blend planting soil before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
2. Spread planting soil to a depth of 12 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Architect/Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: Broadcast dry product uniformly over prepared soil at the manufacturer’s recommended rate.

3.5 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter.
2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.

B. Unamended subsoil removed from excavations may not be used as planting soil.

C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.6 TREE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set stock plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Use amended planting soil for backfill.
2. Balled and Burlapped: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Container-Grown: Carefully remove root ball from container without damaging root ball or plant.
4. Fabric Bag-Grown Stock: Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
5. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
6. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
7. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.7 MECHANIZED TREE SPADE PLANTING

A. Trees shall be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

C. Cut exposed roots cleanly during transplanting operations.

D. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.

E. Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in the same direction as in its original location.

3.8 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

C. Do not apply pruning paint to wounds.

3.9 TREE STABILIZATION

A. Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least one-third of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree. Or,
3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Staking and Guying: Stake and guy trees more than 14 feet in height and more than 5 inches in caliper unless otherwise indicated. Securely attach no fewer than three guys to stakes 30 inches long, driven to grade.

1. Site-Fabricated Staking-and-Guying Method:

For trees more than 6 inches in caliper, anchor guys to duckbills buried at least 36 inches below grade. Provide turnbuckle for each guy wire and tighten securely.
Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
Support trees with strands of cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
Attach flags to each guy wire, 30 inches above finish grade.

3.10 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated in even rows with triangular spacing.

B. Use amended planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.11 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 24-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.12 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use practices to minimize the use of pesticides and reduce hazards.

D. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with College's operations and others in proximity to the Work. Notify College before each application is performed.

3.13 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with College's operations and others in proximity to the Work. Notify College before each application is performed.

B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.14 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.15 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off College's property.

END OF SECTION 329300

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Cleanouts.
4. Drains.
5. Manholes.
6. Channel drainage systems.
7. Catch basins.
8. Stormwater inlets.
9. Stormwater detention structures.
10. Pipe outlets.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

E. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by College or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect/Engineer and College's Representative no fewer than 14 days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect/Engineer's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.2 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, T-1wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.3 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.

1. Bell-and-spigot ends and gasketed joints with ASTM C 443, rubber gaskets
2. Class IV, Wall B.

B. Reinforced-Concrete Low Head Pressure Sewer Pipe and Fittings: ASTM C 361.

1. Tongue-and-groove ends and gasketed joints with ASTM C361, rubber gaskets
2. Class C-25

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
3. Top-Loading Classification(s): Light Duty, Medium Duty, Heavy Duty, and Extra-Heavy Duty.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:
1. MDSHA or Montgomery County standard as indicated on the plans.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.

3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.7 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. MDSHA Standard: MDSHA or Montgomery County standard as indicated on the plans

2.8 PVC SURFACE DRAINAGE INLETS

A. PVC Surface Drainage Inlets: PVC Body with PVC pipe connection stubs manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASMT D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The pipe stock used to manufacture the main body and pipe stubs of the surface drainage inlets shall meet the mechanical property requirements for fabricated fittings as described by ASTM D3034, Standard for Sewer PVC Pipe and Fittings; ASTM F1336, Standard for PVC Gasketed Sewer Fittings.

1. Available Manufacturers:

a. Nyloplast
b. HARCO

2. Top-Loading Classification(s): Heavy duty.

2.9 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to utility standards.

B. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty, according to utility standards.

2.10 STORMWATER DETENTION STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete wall of depth, shape, dimensions, and appurtenances indicated.

2.11 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Riprap Basins: Class I

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping with 24-inch minimum cover, unless otherwise indicated.
3. Install PE corrugated sewer piping according to ASTM D 2321.
4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
1. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
2. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
4. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.

5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
6. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade unless otherwise indicated.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in roads.

B. Embed drains in 4-inch minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

F. Embed trench sections in 4-inch minimum concrete around bottom and sides.

3.6 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.7 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.8 PVC SURFACE DRAINAGE INLETS

A. Install drainage inlets in accordance with the manufacturer’s recommendations.

3.9 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.10 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.11 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.12 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping according to ASTM F 1417.
    c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.14 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.with water.

3.15 STORMWATER MANAGEMENT AS-BUILT CERTIFICATION

A. The construction of all Stormwater Management facilities shall conform to the approved drawings, Montgomery County Stormwater Management construction standards, MDE Stormwater Design Manual Volumes I&II, and the State of Maryland Highway Standard Specifications. The Contractor is responsible for fully understanding the design and function of the proposed facilities and for constructing facilities in full compliance with design standards. The Contractor shall ensure that all of the required plan checklists are signed by the appropriate individuals at the required stages of construction. The Contractor shall verify all critical inverts and elevations throughout construction to verify conformance with the design and standards. This information shall be provided to the College's Representative and the Architect/Engineer at stages during construction as determined in the field for each individual project. Any adjustments to the construction of the facilities shall be reviewed and approved by the Engineer-In-Charge and MCDPS. Approval of the modifications is required prior to proceeding with construction. The Contractor shall make any corrections and adjustments required to fully provide required design volumes, function, and structural integrity of facilities at no additional cost to the College. The Contractor shall also verify that all site improvements, flow paths, and drainage areas to each facility are in conformance with the approved design plans. The Contractor is responsible for providing As-Built plans and appropriate support documentation to the College's Representative and the Architect/Engineer. The Contractor shall make any and all repairs and modifications required to obtain As-Built approval by MCDPS and final release of permit at no additional costs to the College. The Contractor shall be solely responsible for maintenance of all stormwater-related facilities until final acceptance of the facilities by MCDPS, and shall perform full cleanout and/or dredging of facilities prior turn over to the College.

END OF SECTION 334100